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Annex A – Alpine GIG

Annex A – Part 1: Data basis

Austrian method

Information about the macrophyte vegetation is available for 38 natural lakes with a surface area >50 ha. It stems mainly from surveys carried out in 2002 and 2003 in different ways and extents:

- Complete information derived from overall mapping by scuba diving according to Melzer *et al.* (1986) (1 lake)
- Complete information derived from overall mapping by scuba diving according to Pall (1999) (2 lakes),
- Detailed information derived from combined mapping by scuba diving and echo-sounding according to Jäger *et al.* (2004) (6 lakes),
- Random sampling by mapping along belt transects (Pall 2003) without echo-sounding (29 lakes).

The data basis is still rather homogeneous, as the transect-mapping was carried out in all lakes investigated in the same way following Pall (2003). The whole data basis consists of 482 transects.

German method

Information about the macrophyte vegetation of the alpine region is available for 63 lake years (containing 44 natural lakes with a surface area >50 ha). The surveys were manly carried out from 2000 and 2004 in two different ways:

- Complete information derived from overall mapping by scuba diving according to Melzer *et al.* (1986) (25 lakes)
- Random sampling by mapping along belt transects (Schaumburg *et al*. 2005) (32 lakes).

The data basis is rather homogeneous as the transect-mapping was carried out using the same depth zones and macrophyte abundance classes as Melzer *et al.* (1986). The whole data basis consists of 272 transects/lake sections.

Table A-1 lists the sites that were included in the bilateral intercalibration.

Table A-1. Lakes used for the bilateral intercalibration on macrophytes. Mapping transects considered to represent reference conditions are marked with "x". The final assessment of the transect data using the Austrian and the German classification method. EQR values were transformed on a continuous and linear scale with equidistant class widths.

Lake_site	Country	IC	Ref	AT EQR_{norm}	GE EQR_{norm}
Alpse2034	Germany	L-AL3	x	0,8416	0,9492
Alpse2622	Germany	L-AL3	x	0,8611	0,9709
Alpse2623	Germany	L-AL3	x	0,8082	0,9480
Alpse2624	Germany	L-AL3		0,5629	0,7755
Alpse50406	Germany	L-AL3		0,7410	1,0000
Alpse50407	Germany	L-AL3		0,7799	0,9849
Alpse50408	Germany	L-AL3	x	0,8607	0,9906
Alpse50409	Germany	L-AL3		0,7623	0,9594
Alpse50438	Germany	L-AL3		0,6687	0,9663
Boden2611	Germany	L-AL3		0,5900	0,4930
Boden943	Germany	L-AL3		0,6382	0,6052
Chiem2691	Germany	L-AL3		0,5113	0,1754
Chiem2693	Germany	L-AL3		0,6444	0,4491
Chiem2695	Germany	L-AL3		0,7132	0,4416
Chiem2699	Germany	L-AL3		0,7392	0,5093
Chiem2700	Germany	L-AL3		0,7173	0,6447
Chiem2701	Germany	L-AL3		0,7227	0,4766
Chiem2703	Germany	L-AL3		0,7602	0,6802
Chiem50421	Germany	L-AL3		0,6796	0,5512
Chiem50452	Germany	L-AL3		0,7286	0,5388
Chiem50453	Germany	L-AL3		0,7379	0,6637
Chiem897	Germany	L-AL3		0,7623	0,6895
Gr. A50449	Germany	L-AL3		0,4644	0,5161
Gr. A50456	Germany	L-AL3		0,4739	0,4278
Gr. A50458	Germany	L-AL3		0,5046	0,5589
Gr. A50460	Germany	L-AL3		0,3823	0,5885
Gr. A50461	Germany	L-AL3		0,4476	0,4277
Gr. A50468	Germany	L-AL3		0,3952	0,4968
Koche2042	Germany	L-AL3		0,5400	0,3986
Koche2654	Germany	L-AL3		0,5800	0,3886
König2043	Germany	L-AL3		0,6779	0,8417
König2821	Germany	L-AL3		0,7182	0,7945
König2822	Germany	L-AL3		0,6059	0,6912
König2823	Germany	L-AL3		0,6479	0,8552
Obers20037	Germany	L-AL3		0,6000	0,6031
Obers2824	Germany	L-AL3		0,6424	0,9329
Obers2825	Germany	L-AL3		0,7852	0,7604
Obers2826	Germany	L-AL3		0,7293	0,9559
Schli2048	Germany	L-AL3		0,5735	0,4024
Schli2451	Germany	L-AL3		0,6836	0,6438
Schli2665	Germany	L-AL3		0,5974	0,6397
Schli2666	Germany	L-AL3		0,6000	0,5336
Staff2051	Germany	L-AL3		0,5769	0,6289
Staff2673	Germany	L-AL3		0,6470	0,5933
Staff2674	Germany	L-AL3		0,4765	0,4944
Staff2675	Germany	L-AL3		0,5921	0,6105

Lake_site	Country	IC	Ref	AT EQR_{norm}	GE EQR_{norm}
Starn2052	Germany	L-AL3		0,5398	0,3094
Starn2708	Germany	L-AL3		0,6347	0,5782
Starn2709	Germany	L-AL3		0,7143	0,6825
Starn2710	Germany	L-AL3		0,7144	0,6642
Starn2712	Germany	L-AL3		0,5336	0,5695
Starn2713	Germany	L-AL3		0,6565	0,6080
Starn2714	Germany	L-AL3		0,6847	0,6658
Starn2716	Germany	L-AL3		0,7244	0,6585
Starn2717	Germany	L-AL3		0,6957	0,5256
Teger2679	Germany	L-AL3		0,7839	0,7867
Teger2680	Germany	L-AL3		0,7086	0,6073
Teger2681	Germany	L-AL3		0,5635	0,4726
Weiss2686	Germany	L-AL3		0,5250	0,3017
Weiss2687	Germany	L-AL3		0,6151	0,6806
Weiss2688	Germany	L-AL3		0,6669	0,7897
Woert2636	Germany	L-AL3		0,6607	0,8051
Woert50395	Germany	L-AL3		0,5637	0,5940
Woert50397	Germany	L-AL3		0,5060	0,3846
ER01	Austria	L-AL3		0,8431	0,9607
ER02	Austria	L-AL3		0,8337	0,8952
ER03	Austria	L-AL3		0,8746	0,9893
ER04	Austria	L-AL3		0,8531	0,9917
LU01	Austria	L-AL3		0,7972	0,7549
LU02	Austria	L-AL3		0,7638	0,8676
LU03	Austria	L-AL3		0,8111	0,9533
LU04	Austria	L-AL3		0,7564	0,6863
FU01	Austria	L-AL3		0,8203	0,7034
FU02	Austria	L-AL3		0,9153	0,9389
FU03	Austria	L-AL3	x	0,9545	0,9636
FU04	Austria	L-AL3	x	0,9559	0,9649
FU05	Austria	L-AL3		0,8592	0,8556
TR01	Austria	L-AL3		0,4133	0,1539
TR02	Austria	L-AL3		0,5577	0,5306
TR03	Austria	L-AL3		0,6801	0,7410
TR04	Austria	L-AL3		0,3648	0,3692
TR05	Austria	L-AL3		0,4307	0,4342
WE01	Austria	L-AL3		0,8853	0,7230
WE02	Austria	L-AL3		0,9007	0,9225
WE03	Austria	L-AL3		0,8222	0,7130
WE04	Austria	L-AL3	x	0,9372	0,9689
WE05	Austria	L-AL3	x	0,9328	0,9721
MO01	Austria	L-AL3		0,5505	0,4328
MO02	Austria	L-AL3		0,5079	0,3503
MO03	Austria	L-AL3		0,5384	0,4074
MO04	Austria	L-AL3		0,4922	0,2220
MO05	Austria	L-AL3		0,4482	0,0769
MO06	Austria	L-AL3		0,4211	0,3380
MO07	Austria	L-AL3		0,5451	0,2584
MO08	Austria	L-AL3		0,6351	0,5323
MO09	Austria	L-AL3		0,5686	0,5575
MO10	Austria	L-AL3		0,4133	0,3224

Lake_site	Country	IC	Ref	AT EQR_{norm}	GE EQR_{norm}
AT01	Austria	L-AL3		0,8858	0,7960
AT02	Austria	L-AL3		0,6853	0,4182
AT03	Austria	L-AL3		0,9124	0,9155
AT04	Austria	L-AL3		0,8749	0,8233
AT05	Austria	L-AL3		0,7713	0,5494
AT06	Austria	L-AL3		0,9081	0,8869
AT07	Austria	L-AL3		0,7858	0,5993
AT08	Austria	L-AL3	x	0,9540	0,9421
AT09	Austria	L-AL3		0,7955	0,6873
AT10	Austria	L-AL3		0,8953	0,8563
Lan01	Germany	L-AL4		0,7398	0,7037
Lan04	Germany	L-AL4		0,6581	0,7185
Lan05	Germany	L-AL4		0,8302	0,7334
Lan06	Germany	L-AL4		0,7255	0,7334
Lan07	Germany	L-AL4		0,7118	0,7185
Lan08	Germany	L-AL4		0,7603	0,5545
Pil01	Germany	L-AL4		0,5477	0,5909
Pil02	Germany	L-AL4		0,6659	0,6889
Pil05	Germany	L-AL4		0,5967	0,5091
Pil06	Germany	L-AL4		0,5942	0,6074
Rie02	Germany	L-AL4		0,8443	0,6000
Rie03	Germany	L-AL4		0,6620	0,5545
Rie07	Germany	L-AL4		0,6651	0,4363
Tac01	Germany	L-AL4		0,6023	0,6371
Tac02	Germany	L-AL4		0,6870	0,7482
Tac03	Germany	L-AL4		0,6540	0,6445
Tac04	Germany	L-AL4		0,6223	0,6815
Tac05	Germany	L-AL4		0,7261	0,6815
Tac06	Germany	L-AL4		0,6352	0,7334
Tac07	Germany	L-AL4		0,5988	0,5636
Tac08	Germany	L-AL4		0,5752	0,5727

Annex A – Part 2: National classification methods

1. Austrian classification method on macrophytes: AIM (=Austrian **I**ndex **M**acrophytes).**)**

a) Status

Macrophytes do not reflect only the trophic conditions in a lake, but respond very sensitively to other impacts on their environment, especially structural alterations of the shoreline and changes of the hydrological regime. With regard to these aspects, Austrian assessment method consists of three different modules:

Module 1: Trophic state and general degradation,

Module 2: Structure (alteration of the shoreline and the littoral),

Module 3: Hydrology (water level fluctuations)

At the moment **AIM Module 1** ("Trophic state and general degradation") is used for the WFD assessment in Austria. The two other modules of the Austrian system "Structure" and "Hydrology" are only optional modules and developed for special cases. But to a certain extent the structural and the hydrological aspect are included in the "general degradation" of module 1. The kind of pressure can be specified in each case.

Within the present IC exercise, only AIM Module 1 is taken into consideration. Besides, the modules 2 and 3 are substantially based on the emerged vegetation (helophytes and amphiphytes), which is not included in the German method and can thus not be used within the intercalibration.

The Austrian classification method on macrophytes was finalised in 2006 and exists in a nationally agreed version (BMLFUW 2007). Detailed information and sampling protocols are given in Pall & Moser (2007a). An English version is now available (Pall & Moser 2007b).

b) Mapping method

The Austrian mapping procedure is compliant with prEN 15640. Mapping can be done from mid June until September. Helophytes, floating leafed plants and the submerged vegetation are included in the survey. Higher plants (Spermatophyta), aquatic ferns (Pteridophyta) and mosses (Bryophyta) as well as stoneworts (Charophyta) are determined to species level.

The field survey is carried out along belt transects by scuba diving (Pall 2003). Each transect has a lateral extension of 25 m and reaches from the long term mean water level to the depth spread boundary of the macrophyte vegetation. During the mapping each transect is divided in different depth zones according to the natural boundaries of the different vegetation types (for example: reed belt, charophytes of the shallow water, pondweed belt *etc*.).

Within each depth zone of a transect, the quantity of all identified species is estimated on a five level scale (Kohler 1978): 1 = very rare, 2 = rare, 3 = common, 4 = frequent, 5 = abundant. Additionally, information on sediment composition, slope and degree of shading, the type of the surrounding vegetation and the land use is recorded.

For the whole lake assessment in Austria this method of transect mapping is usually applied in combination with echo-sounding (Jäger *et al.* 2004). The echo-sounding is done prior to the detailed mapping and allows the identification of different structure and forms of the submerged vegetation along the shoreline. This information enables to select the optimum amount and location of representative transects. The echo-sounding ensures also that the results from the transect mapping can be correctly extrapolated to the whole lake.

Where echo-sounding data are not available, the number of required transects and their location along the shore line is selected on expert judgement based on the structural situation (similar approach as in the German method).

c) Metrics

The WFD requires that the assessment shall correspond to the degree of deviation of the surveyed species community from the reference species community. Hereby species composition and abundance shall enter the assessment.

In a first attempt the method was based exclusively on a concrete macrophyte community (set of species including abundances). A statistical distance measure between an existing set of species and a reference set of species was calculated. This leads to plausible results only for some (oligotrophic) lakes in Austria. In many other lakes (even in also oligotrophic or oligo-mesotrophic lakes) arose a not plausible „need for action“ due to a complete or heavy deflection of the set of species.

The reason is that the macrophytes last behind if re-oligotrophication happens – and this apparently even more, the more towards the oligotrophic state. Thereby different categories react variably quickly:

1. the vegetation density returns to the original status,
2. the depths spread boundary comes back to the deep,
3. the type specific zoning is rebuilt
4. the species composition adapts to the trophic level,
5. the reference species community occurs again.

To take this into account, the assessment method was enhanced with four additional metrics (Table A-2). These metrics cover the whole range from short time (vegetation density) to long time reactors (concrete set of species).

Table A-2. Metrics and parameters used in the Austrian classification method for macrophytes.

Metric	*parameter*
Vegetation density	CMI (Pall 1996)
Depth spread boundary	Depth [m]
Zoning	Occurrence of type specific vegetation zones
Trophic Indication	Macrophyte Index (Melzer *et al.* 1986)
Concrete set of species	Bray Curtis similarity index

For each metric the deviation of the actual value from the reference condition (=median of values from reference sites) is calculated. The ecological quality class results as the mean of these five metrics.

Boundary setting see Technical report Part 2 Section 2 Table 2.1.4b

2. German classification method on macrophytes

a) Status

The German classification method on macrophytes & phytobenthos was finalised in 2004, some modifications were made in 2005. It is a nationally agreed method and already published. Detailed information about the entire approach (macrophytes and diatoms) and sampling protocols can be downloaded at the homepage of the Bavarian Environment Agency (see SCHAUMBURG *et al.* 2004, 2005):

http://www.lfu.bayern.de/wasser/forschung_und_projekte/phylib_englisch/index.htm

For further information to the development of the macrophyte method see STELZER *et al.* (2005). Please note that for a complete lake classification, a diatom survey additionally to the macrophyte mapping is required.

b) Macrophyte sampling and abundance

Submerged and free floating aquatic macrophyte (charophytes, bryophytes and tracheophytes) abundance is estimated once during summer, *i.e.* the main growing season of macrophytes (usually mid June until mid September).

At each lake 4–50 sites are investigated depending on lake size and homogeneity (in morphology, exposition, substratum, structure of shore, land use, *etc*.). In each sampling site an ecologically homogeneous belt transect of 20–30 m width orthogonal to the shoreline is surveyed, with each site being divided into four depth zones (0–1 m, 1–2 m, 2–4 m and >4 m). Transects can either be surveyed by scuba divers or by using a boat and adequate equipment.

For all depth zones the abundance of each species observed is determined according to a 5 degree scale, where 1 = very rare, 2 = rare, 3 = common, 4 = frequent and 5 = abundant/predominant (KOHLER 1978). In addition, the growth form (submerged or emerged) of the plants is noted. The depth of the vegetation limit is noted as well as the species occurring in the greatest depth. As far as possible, species are determined to species level.

c) Metrics

In the German method, four metrics are used:

- Reference Index
- Depth of vegetation limit
- Dominant stands of specific species
- Depopulation of submerged macrophytes

For calculation of the Reference Index, exclusively submerged and free floating species of the sampling site are considered. Amphiphytic taxa are taken into account if they occur submerged.

Prior to performing any calculations, the nominally scaled values of plant abundance (after Kohler) are converted into metric quantities using the following function:

$$\text{(macrophyte abundance)}^3 = \text{quantity}$$

The quantities for the individual species are summed up for the different depth zones.

The taxa occurring at the sampling site will be assigned to three type specific species groups (Schaumburg *et al.* 2005). In Species group A all taxa are listed, which are abundant under reference conditions and uncommon under non-reference conditions. These taxa belong to the type-specific reference biocoenoses. Species group C are taxa rarely found under reference conditions, and usually occur at sites with very few or no group A taxa. Species group B taxa show no preference for reference or non-reference conditions. They occur together with taxa from species groups A and C.

The quantities of the different species calculated from the plant abundances will be summed up separately for each group and for all submerged species of a sampling site. The Reference Index (RI) is calculated according to the Equation (1):

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

with RI = Reference Index
Q_{Ai} = "Plant quantity" of the i-th taxon of species Group A
Q_{Ci} = "Plant quantity" of the i-th taxon of species group C
Q_{gi} = "Plant quantity of the i-th taxon of all groups
n_A = Total number of taxa of species group A
n_C = Total number of taxa of species group C
n_g = Total number of taxa

The RI is an expression of the "plant quantity" ratio of type-specific sensitive taxa, dominating at reference conditions, compared to the "plant quantity" of insensitive taxa. It is therefore a tool for estimating the deviation of observed macrophyte communities from reference communities. The resulting index values range from +100 (only species group A taxa) to –100 (only species group C taxa).

As additional metrics the depth of vegetation limit and dominant stands of specific species in alpine lakes corresponding to L-AL3 are taken into account in the following way:

- if RI > 0 and vegetation limit is within a range of 5–8 m → RI is reduced by 20
- if RI > 0 and vegetation limit is <5 m → RI is reduced by 50
- if *Elodea canadensis/nuttallii*, *Myriophyllum spicatum* or *Najas marina* subsp. *intermedia* form dominant stands → RI is reduced by 50

As additional metrics the depth of vegetation limit and dominant stands of specific species in alpine lakes corresponding to L-AL4 are taken into account in the following way:

- if RI > 0 and vegetation limit is <4,5 m → RI is reduced by 50
- if *Elodea canadensis/nuttallii*, *Myriophyllum spicatum* or *Najas marina* subsp. *intermedia* form dominant stands → RI is reduced by 50

Boundary setting see Technical report Part 2 Section 2 Table 2.1.4c.

d) Requirements for assessment

The following criteria need to be met to reliably classify ecological status:

- macrophyte abundance estimation using one of the methods described above,
- a minimum of 75 % of the total „plant quantity" are macrophytes contained in species groups A, B and C
- total "plant quantity" of macrophytes contained in species groups A, B and C must exceed 55

If one of these requirements is not met, the ecological status must be denoted as inconclusive and should not be included when integrating macrophyte and phytobenthos assessments for lakes (SCHAUMBURG *et al.* 2004).

If total “plant quantity” of macrophytes does not exceed 55 and natural causes can be excluded, the possibility of macrophyte depopulation must be taken into consideration. If this is the case, the ecological status class 5 is assigned. In locations of the lake subtype AKs, the absence of macrophytes cannot be used to make statements regarding degradation.

e) Composition and abundance of phytobenthos:

Only benthic diatoms (*Bacillariophyceae)* are used as indicators for Phytobenthos. In order to obtain a representative distribution, 500 valves are determined in a prepared slide to the species level. The frequencies are presented as percentages.

Sampling strategy; Monitoring frequency

Preferably stones are sampled in their original position and the periphyton (Aufwuchs) or sediment cover is scratched off with a tea spoon, spatula or a similar device and is transferred into a labeled wide neck sampling container. Generally, sampling is carried out in the open water and not amidst dense stands of macrophytes. The sampling depth should exceed 30 cm. Fluctuations of the water level must be kept in mind when scheduling sampling dates. If mainly sand or soft sediments are present, the upper millimeters are lifted off with a spoon.

The sites are the same as surveyd for macrophytes. The sampling can be done together once during summer. Samples are transferred into a labeled wide neck sampling jar. Diatoms are preserved by adding formaldehyde of a final concentration of 1–4 %.

At each transect approximately 5 stones are sampled.

The sampling can be done together with macrophyte monitoring once during summer between 15th June-15th August

Analysis of sample and level of determination

Samples are oxidized (KRAMMER & LANGE-BERTALOT (1986)). Determination with microscope (interference/phase contrast) with 1000- to 1200 fold magnification. A number of 500 shells is determined in a prepared slide to the species level. The 4 volumes of KRAMMER & LANGE-BERTALOT (1986–1991) are used as standard determination literature. It can be completed by the supplementary volumes and revisions of individual species published since 1993 by the following authors: KRAMMER (2000, 2002), LANGE-BERTALOT (1993, 2001), LANGE-BERTALOT & MOSER (1994), LANGE-BERTALOT & METZELTIN (1996).

f) Phytobenthos Metrics

Trophic-Index ($TI_{\text{Süd (south)}}$): diatom index related to trophic status according to HOFMANN (1999).

Quotient of Reference Species“ (RAQ): relative abundance of the diatom species of two different ecological species groups (reference indicators (A) and degradation indicators (C)) according to SCHAUMBURG et al. (2004, 2005).

f1) Trophic index

The indicative species of the trophic index which were found at the littoral site to be assessed and their percentages are the basis for calculating the Trophic Index according to HOFMANN (1999) (Equation 2).

Equation 2: Trophic-Index according to HOFMANN (1999) $TI_{\text{Süd (south)}}$

$$TI_{Süd} = \frac{\sum_{i=1}^{n} H_i * G_i * T_i}{\sum_{i=1}^{n} H_i * G_i}$$

$TI_{Süd}$ = Trophic-Index Süd (South)
H_i = Percentage of the i-th species
G_i = Weighting of the i-th species
T_i = Trophic value of the i-th species

For the combination with the „Quotient of Reference Species (RAQ)“ the calculated values of the „Trophic-Index (TI)“ are transformed according to the following equation 3.

Equation 3: Transformation of the calculated trophic value $TI_{Süd(South)}$)

$$M_{TI_{Süd}} = 1 - ((TI_{Süd} - 1) * 0,25)$$

$M_{TISüd}$ = Module Trophic-Index Süd(South)
$TI_{Süd}$ = calculated Trophic-Index$_{Süd(South)}$

If module values calculated with Equation 4 are greater than 1, the result is set to be 1. For values smaller than 0, the value is set to be 0.

f2) „Quotient of Reference Species“ (RAQ)

The type specific occurrence in different ecological conditions is used to distinguish two different species groups.
For assessment the quotient of reference species is determined under consideration of the type specific reference species and their ecological groups. Only the number of species is considered whereas the abundance of the individual species is neglected (compare Equation 4).

Equation 4: Calculation of the quotient of reference species for the lakes of the Alps and the Alpine Foreland

$$RAQ = \frac{Number\ of\ taxa\ B - Number\ of\ taxa\ C}{Number\ of\ taxa\ B + Number\ of\ taxa\ C}$$

The RAQ-values are transformed according to equation 5.

Equation 5: Transformation of the type specifically calculated quotient of reference species

$$M_{RAQ} = (RAQ + 1) * 0,5$$

M_{RAQ} = Module Quotient of Reference Species
RAQ = calculated Quotient of Reference Species

The overall assessment of the component Phytobenthos-Diatoms is carried out by a combination of the modules „Trophic-Index (TI)“ and „Quotient of Reference Species (RAQ)“. For this purpose the arithmetic mean of the results is determined to obtain the Diatom- Index$_{Seen}$ ($DI_{Seen(Lakes)}$) following Equation 6.

Equation 6: Calculation of the $DI_{Seen(Lakes)}$

$$DI_{Seen} = \frac{M_{RAQ} + M_{TI}}{2}$$

DI_{Seen} = Diatom-Index$_{Seen(Lakes)}$
M_{RAQ} = Module Quotient of Reference Species
M_{TI} = Module Trophic-Index

g) Combination of the metrics Macrophytes and Diatoms

Calculation of the index is carried out according to Equation 7. If an individual module cannot be considered reliable, the Macrophyte-Phytobenthos Index for lakes ($M\&P_{Seen/Lakes}$) corresponds to the reliably calculated module. However, the result must critically be verified.

Equation 7: Calculation of the Index $M\&P_{Seen/Lakes}$ for determination of the ecological status in case of two reliable modules.

$$M\&P_{Seen/Lakes} = \frac{M_{MP} + M_D}{2}$$

$M\&P_{seen/Lakes}$= Macrophyte & Phytobenthos-Index for lakes
M_{MP} = Module Macrophytes
M_D = Module Diatoms

According to lake types, the $M\&P_{Seen/Lakes}$-values are assigned to ecological quality classes.

In all ecoregions the reason for an absence of macrophytes and therefore an unreliable module Macrophytes must be determined. If, for example due to physicochemical parameters, structural modifications (embankments), mowing, introduction of fish or other anthropogenic influences a macrophyte depopulation is proved, an overall assessment of “high” or “good” (Macrophytes & Phytobenthos) must be downgraded to the status class 3.

The whole lake assessment is derived from the mean of the transect EQRs.

Comparison of the Austrian and the German classification method on macrophytes & phytobenthos

Table B-3 gives a short comparison of the two classification methods using macrophytes & phytobenthos. The two methods differ mainly in the way of transect and depth zone determination and in national typology, i.e. the relevance of slightly different reference trophic states the definition of macrophyte reference conditions (see above). The Austrian approach postulates types with different reference conditions depending on lake altitude. Reference conditions were mainly derived from actual survey data, assuming that Austria still contains a sufficient number of sites (not necessarily whole lakes) in reference condition. In Germany, where not enough undisturbed lakes existed, reference status had to be derived using additional data from literature and sediment analyses (paleo-reconstruction). Also phytobenthos-diatoms has to be included, because the use of macrophytes only would lead to a wrong classification in many cases of AL4-lake type lakes under ongoing reoligotrophcation. The diatom module as short time reactor has to outweigh macrophytes as long time reactor.

In the present IC exercise, only sites within a lake (transects) can be used for the intercalibration of the Austrian and the German method.

Table A-3. Comparison of the Austrian and German method for the classification of standing waters using macrophytes & phytobenthos.

	Germany	*Austria*
Field survey	Transects (rake or scuba diving), collecting diatoms from stones	Transects (scuba diving)
Determination of transect number and location	Derived from lake size and shape, usage of shore and catchment area	Based on the results of a preceding echo-sounding (Jäger *et al.* 2004) (or, if not available, alternatively according to the German method)
Organism groups		
submerged	+	+
free floating	+	+
floating leafed	+	+
amphiphytic	–	+
helophytic	–	+
phytobenthos	+	–
Macrophyte identification	charophytes, bryophytes and tracheophytes to the species level	
Abundance scale	5 level scale (Kohler 1978)	
Phytobenthos	Percentage of 500 Objects	
Determination of depth zones	0–1 m, 1–2 m, 2–4 m and >4 m	Derived from actual depth zoning of the different macrophyte communities
Classification metrics	- Reference Index (RI) - Depopulation of macrophytes - Dominant stands of specific species - Limit of vegetation - Trophic Diatom Index - Reference species quotient	- Vegetation density - Depth spread boundary - Zoning - Trophic index - Concrete set of species
Whole water body classification	Mean of transect results	Weighted mean of transect results according to the results of the echo-sounding

Annex B – Central/Baltic GIG

Annex B – Part 1 - Description of national methods included in the intercalibration

Monitoring and assessment methods of the quality element aquatic flora in Central European Member States

Case: DE
Status: national input for intercalibration, accepted national method, slight adjustments are still possible

Which indicators are used?

Macrophyte taxonomic composition:
The taxanomic composition of hydrophytes is assessed on species level. Hydrophytes includes angiosperms, charophytes and some mosses. Other macroalgea (e.g. *Hydrodiction* sp.) are not included. Only submerged, floating-leaved and free floating macrophytes are considered as indicators.

Macrophyte abundance:
The species composition uses a 5 classes of abundance, see table 1. The abundance of the species for each depth zone at each transect is recorded separately.

Table 1. The German species abundance scale.

1	very rare
2	rare
3	common
4	frequent
5	abundant/predominant

Composition and abundance of phytobenthos:
Only benthic diatoms (*Bacillariophyceae)* are used as indicators for Phytobenthos. In order to obtain a representative distribution, 500 valves are determined in a prepared slide to the species level. The frequencies are presented as percentages.

Bacterial tufts:
Bacterial tufts are not used in the assessment of the quality element, because of lack of data and information for suitable indicators and its reference values.

Summary
For the German method macrophtes and diatoms are assessed separately and then combined to one EQR. The lake assessment is calculated as the mean of transect results.

<u>Macrophytes:</u>
<u>reference index (RI):</u> relative abundance of the macrophyte species of three different typespecific ecological species groups (reference indicators, indifferent taxa, degradation indicators; according to growth depth, most taxa are assigned to different groups)
<u>limit of vegetation:</u> used as an additional criteria
<u>dominant stands:</u> used as an additional criteria if a single species (e.g. *Ceratophyllum demersum* or *Myriophyllum spicatum*) reaches at least 80% of total plant quantity (see below).

Phytobenthos:
Trophic-Index ($TI_{Nord(North)}$): diatom index related to trophic status according to Schönfelder et al. (unpublished)
Quotient of Reference Species" (RAQ): relative abundance of the diatom species of two different ecological species groups (reference indicators (A) and degradation indicators (C))

How are these indicators monitored?

Sampling strategy

Macrophytes
Each transect covers a minimum of 20 m of homogeneous shoreline and is divided into 0–1 m, 1–2 m, 2–4 m and >4 m depth classes. Transects can be surveyed either using SCUBA or by boat using a water viewer and a double rake with rope. For data analyses, the macrophyte abundance data is transformed into "plant abundance" using the function $y = x^3$.

Phytobenthos
Preferably stones are sampled in their original position and the periphyton (Aufwuchs) or sediment cover is scratched off with a tea spoon, spatula or a similar device and is transferred into a labeled wide neck sampling container. Generally, sampling is carried out in the open water and not amidst dense stands of macrophytes. The sampling depth should exceed 30 cm. Fluctuations of the water level must be kept in mind when scheduling sampling dates. If mainly sand or soft sediments are present, the upper millimetres are lifted off with a spoon.
The sites are the same as surveyd for macrophytes. The sampling can be done together once during summer.

Numbers of samples per lake

Macrophytes
According to lake size and shape, usage of shore and catchment area 4 to 30 transects (=sites) are investigated. Each transect covers a minimum of 20 m of homogeneous shoreline (=width) and reaches from shore to vegetation limit (=variable length). If transects are investigated by a rake, at least five samples are taken in each depth class (20 samples per transect). Macrophyte abundance is recorded for each depth class separately but not for each sample.

Phytobenthos
At each transect approximately 5 stones are sampled.

When is monitored and with which frequency?

Macrophytes
Samples are taken once in the middle of growing season i.e. 15th June-15th August.

Phytobenthos
The sampling can be done together with macrophyte monitoring once during summer.

Use of equipment

Macrophytes
Sampling can be done in two different ways:

- using SCUBA equipment
- by boat, using a water viewer in combination with a double rake connected to a rope

In any case sampling bags and cool bags are used to store species for later determination (mosses, charophytes).

Phytobenthos
Samples are taken with a tea spoon, spatula or a similar device and transferred into a labeled wide neck sampling jar. Diatoms are preserved by adding formaldehyde of a final concentration of 1–4 %.

Analysis of sample and level of determination

Macrophytes
Most plants are determined to species in the field, and partly validated in the laboratory. Charophytes and mosses are determined to genus or higher taxa in the field and collected for species determination.

Phytobenthos
Samples are oxidized (KRAMMER & LANGE-BERTALOT (1986)). Determination with microscope (interference/phase contrast) with 1000- to 1200 fold magnification. A number of 500 shells is determined in a prepared slide to the species level. The 4 volumes of KRAMMER & LANGE-BERTALOT (1986–1991) are used as standard determination literature. It can be completed by the supplementary volumes and revisions of individual species published since 1993 by the following authors: KRAMMER (2000, 2002), LANGE-BERTALOT (1993, 2001), LANGE-BERTALOT & MOSER (1994), LANGE-BERTALOT & METZELTIN (1996).

Way of reporting basic data

There is not yet a strict procedure for data management or for reporting basic data for the assessment.

Assessment

Data requirements

A software tool for the automatically calculation of the German assessment is under development. Therefore some parameters in the given tables may be changed in near future. Table 2 and 3 give examples for input files of environmental data and macrophyte/phytobenthos data respectively.

Table 2. Example of an input table of environmental data.

lake	eco region	catchment area	volume	mean depth	vegetation limit	alkalinity	mixis	residence time	lake type (LAWA)
5700	4	12	77,04	5	2.7	2,2	1	16,5	10
5701	4	23	16,91	7	5.2	2,3	1	24	13

Table 3: Example of an input table of macrophyte/phytobentos data. Note that txa are recorded as “DV-numbers” which will be automatically assigned to “macrophytes” or “phytobenthos”;”growthform” is only relevant for macrophyte data; “abuncance” has to be given according to “unit” either in percent values (1) or abundance classes (3).

lake	site	depth class	taxon	growth form	abundance	unit	cf
5700	1	1	2018	262144	1	3	
5700	1	1	2074	16384	3	3	
5700	1	1	6051		35	1	
5700	1	1	6020		15	1	
5700	1	1	6726		50	1	
5700	1	2	2074	16384	2	3	
5700	1	3	2574	16384	3	3	
5700	2	1	2054	8192	1	3	
5701	1	1	2992	262144	4	3	

Methods of calculation

Macrophytes

Prior to performing any calculations, the nominally scaled values of plant abundance are converted into metric quantities using the following function:

macrophyte abundance^3 = quantity

The taxa occurring at the sampling site will be assigned to type specific species groups (compare Annex A). Taxa found in differing depth zones are treated as different taxa (e.g. taxon A in 0–1 m, taxon A in 1–2 m, …). The quantities of the different species will be summed up separately for each group and for all submerged species of a sampling site. The Reference Index is calculated according to the following formula (Equation 1):

Equation 1: 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 species group A*
QCi = *Quantity of the i-th taxon of species 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*

The RI is an expression of the “plant quantity” ratio of type-specific sensitive taxa, dominating at reference conditions, compared to the “plant quantity” of insensitive taxa and is therefore a tool for estimating the deviation of observed macrophyte communities from reference communities. The resulting index values range from +100 (only species group A taxa) to –100 (only species group C taxa).
The additional criteria provided in table 4 used are type related correcting factors of the RI.
In order to calculate the Reference Index, the respective type specific characteristics and prerequisites have to be considered.

Table 4: correcting factors for different lake types

German lake type	intercalibration type	correcting factors
TKg10	LCB 1	if RI > 0 and vegetation limit < 5 m → RI is reduced by 50 if dominant stands of one of the following taxa occur, RI is reduced by 50: *Ceratophyllum demersum, C. submersum, Elodea canadensis/ nuttallii, Myriophyllum spicatum, Najas marina subsp. intermedia* or *Potamogeton pectinatus*
TKg13	LCB 1	if RI > 0 and vegetation limit > 5 m and < 8 m → RI is reduced by 20 if RI > 0 and vegetation limit < 5 m → RI is reduced by 50

		if dominant stands of one of the following taxa occur, RI is reduced by 50: *Ceratophyllum demersum, C. submersum, Elodea canadensis/ nuttallii, Myriophyllum spicatum, Najas marina subsp. intermedia* or *Potamogeton pectinatus*
TKp	LCB 2	if dominant stands of one of the following taxa occur, RI is reduced by 50: *Ceratophyllum demersum, C. submersum, Elodea canadensis/ nuttallii, Myriophyllum spicatum, Najas marina subsp. intermedia* or *Potamogeton pectinatus* if RI > 0 and vegetation limit < 3 m → RI is reduced by 50

In order to create a basis for comparison for the metrics Macrophytes and Diatoms and to obtain EQR values, the index values must be transformed. A unified scale from "0" to "1" is suitable. The value "1" represents the best ecological status according to the WFD, i.e. status class 1. The value "0" stands for the highest degree of degradation of a water body, i.e. status class 5. The transformation for the module „Macrophytes" (Reference Index, RI) is carried out according to Equation 2.

Equation 2: Transformation of the module RISeen/Lakes (Reference IndexSeen/Lakes Macrophytes) on a scale from 0 to 1.

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

M_{MP} = Module Macrophyte Assessment
$RI_{Seen/Lakes}$ = type specifically calculated Reference $Index_{Seen/Lakes}$

The classification of the EQR values into the categories of ecological status is based on the definitions for ecological status, given by Annex V of the Water Framework Directive (Table 5).

Table 5: Classification of the RI values into the categories of ecological status.

ecological status	Range of RI/EQR	Definition given by the WFD	Interpretation
High	>50 / >0.75	"The taxonomic composition corresponds totally or nearly totally to undisturbed conditions. There are no detectable changes in the average macrophytic […] abundance. […]"	RI values lie within the range of reference sites.
Good	0 to 50 / 0.5 to 0.75	"There are slight changes in the composition and abundance of macrophytic […] taxa compared to the type-specific communities. […]"	RI values are slightly below high status and always positive (Taxa of species group A have higher abundances than species group C taxa).
Moderate	-50 to 0 / 0.25 to 0.5	"The composition of macrophytic […] taxa differ moderately from the type specific communities and-are significantly more distorted than those observed at good quality. Moderate changes in the average macrophytic […] abundance are evident. […]"	RI values are around zero or negative (species group C taxa equal or slightly outweigh species group A taxa).
Poor	-100 to -50/ 0.0 to 0.25	Macrophyte "communities deviate substantially from those normally associated with the surface water body type under undisturbed conditions".	RI values are very low (species group A taxa are nearly replaced by species group C taxa).
Bad	0.0	"Large portions of the relevant biological communities normally associated with the surface water body type under undisturbed conditions are	Very low macrophyte abundances without natural reasons. (Calculation of RI is often not possible)

Table 6 provides an example for the German macrophyte assessment.

Table 6: An example for calculation of species metric for a TKg10 (= LCB 1) type lake.

species at transekt 1	abundance (0-5) / quantity	species group (see AnnexA)	Calculation	EQR
P. pectinatus (0-2m)	3/27	B	RI = 12.66; vegetation limit = 3,8m →RI is reduced by 50 to **–37.33**	0.31 (moderate)
P. pectinatus (1-2m)	4/64	B		
P. perfoliatus (2-4m)	2/8	B		
L. minor (0-1m)	2/8	C		
Chara contraria (0-1m)	2/8	B		
Chara contraria (1-2m)	2/8	B		
Chara contraria (2-4m)	3/27	A		

Phytobenthos: trophic index

The indicative species of the trophic index (AnnexB) which were found at the littoral site to be assessed and their percentages are the basis for calculating the Trophic Index according to Schönfelder et al. (unpublished) (Equation 3).

Equation 3: Trophic-Index according to Schönfelder et al. (unpublished) $TI_{Nord(North)}$

$$TI_{Nord} = \frac{\sum_{i=1}^{n} \sqrt{H_i} * T_i}{\sum_{i=1}^{n} \sqrt{H_i}}$$

$TI_{Nord(North)}$ = Trophic-Index Nord(North)
H_i = Percentage of the i-th species
T_i = Trophic value of the i-th species

For the combination with the „Quotient of Reference Species (RAQ)“ the calculated values of the „Trophic-Index (TI)“ are transformed according to the following equation 4.

Equation 4: Transformation of the calculated trophic value $TI_{Nord(North)}$ (modified according to Schönfelder 2006, unpublished)

$$M_{TI_{Nord}} = 0{,}8 - 0{,}8 * ((TI_{Nord} - TI_{Nord_{H/G}}) / 2{,}00)$$

MTI_{Nord} = Module Trophic-Index $_{Nord(North)}$
0,8 = Module value for transition H/G“
TI_{Nord} = calculated Trophic-Index$_{Nord(North)}$
TI_{Nord} H/G= Value $TI_{Nord(North)}$ of the transition H/G (Table 7)
2,00 = Scale width between classes „high“ and „good“and the type specific worst Trophic-Index$_{Nord}$ with the module value 0,00 (at the lower class limit of the ecological status class “poor”)

Table 7: Value of the $TI_{Nord(North)}$ at the transition „high“ – „good“

Type Diatoms	Transition H/G $TI_{Nord(North)}$
13.1	1,74
13.2 / 10.1	2,24
10.2	2,74
14	1,99
11	2,49
12	2,99

If module values calculated with Equation 4 are greater than 1, the result is set to be 1. For values smaller than 0, the value is set to be 0.

Phytobenthos: „Quotient of Reference Species“ (RAQ)

The type specific occurrence in different ecological conditions is used to distinguish two different species groups (compare Annex C).
For assessment the quotient of reference species is determined under consideration of the type specific reference species and their ecological groups. Only the number of species is considered whereas the abundance of the individual species is neglected (compare Equation 5).

Equation 1: Calculation of the Quotient of Reference Species for the lakes of the North German Lowland

$$RAQ = \frac{Number\,of\ taxa\ A - Number\,of\ taxa\ C}{Number\,of\ taxa\ A + Number\,of\ taxa\ C}$$

The RAQ-values are transformed according to equation 4.

Equation 5: Transformation of the type specifically calculated quotient of reference species

$$M_{RAQ} = (RAQ + 1) * 0{,}5$$

M_{RAQ} = Module Quotient of Reference Species
RAQ = calculated Quotient of Reference Species

The overall assessment of the component Phytobenthos-Diatoms is carried out by a combination of the modules „Trophic-Index (TI)“ and „Quotient of Reference Species (RAQ)“. For this purpose the arithmetic mean of the results is determined to obtain the Diatom- Index$_{Seen}$ ($DI_{Seen(Lakes)}$) following Equation 6.

Equation 6: Calculation of the $DI_{Seen(Lakes)}$

$$DI_{Seen} = \frac{M_{RAQ} + M_{TI}}{2}$$

DI_{Seen} = Diatom-Index$_{Seen(Lakes)}$
M_{RAQ} = Module Quotient of Reference Species
M_{TI} = Module Trophic-Index

Example:
A site within an type 10.1 (LCB 2) lake with a calculated $TI_{Nord(North)}$ = 3,0 leads to a transformed $M_{TI\ Nord(North)}$= 0.096.
The same site with 2 “taxa A” and 8 “taxa C” has an RQA= -0.6 ; transformed into M_{RAQ}=0.2.
→ $DI_{Seen(Lakes)}$=0.148

Combination of the metrics Macrophytes and Diatoms

Calculation of the index is carried out according to Equation 7. If an individual module cannot be considered reliable, the Macrophyte-Phytobenthos Index for lakes (M&P$_{Seen/Lakes}$) corresponds to the reliably calculated module. However, the result must critically be verified.

Equation 7: Calculation of the Index M&P$_{Seen/Lakes}$ for determination of the ecological status in case of two reliable modules.

$$M\&P_{Seen/Lakes} = \frac{M_{MP} + M_D}{2}$$

$M\&P_{seen/Lakes}$= Macrophyte & Phytobenthos-Index for lakes
M_{MP} = Module Macrophytes
M_D = Module Diatoms

According to lake types, the $M\&P_{Seen/Lakes}$-values are assigned to ecological quality classes. Table 8 gives an example for lakes of LCB 2.

In all ecoregions the reason for an absence of macrophytes and therefore an unreliable module Macrophytes must be determined. If, for example due to physicochemical parameters, structural modifications (embankments), mowing, introduction of fish or other anthropogenic influences a macrophyte depopulation is proved, an overall assessment of "high" or "good" (Macrophytes & Phytobenthos) must be downgraded to the status class 3.

Example: M_{MP}= 0.31 and M_D= 0.148 → $M\&P_{Seen\ (Lakes)}$ = 0.229. For a D10.1 diatom type and TKg10 macrophyte type this means a poor ecological status.

The whole lake assessment is derived from the mean of the transect EQRs.

Table 8: Index limits for classification of the ecological status: stratified lakes of the North German Lowland, type 10 according to Mathes et al. (2002)

MATHES et al. (2002)	Type 10	
Macrophytes	TKg10	
Diatoms	D 10.1	D 10.2
Ecological status class		
1	1,00 - 0,77	1,00 - 0,77
2	< 0,77 - 0,53	< 0,77 - 0,53
3	< 0,53 - 0,29	< 0,53 - 0,29
4	< 0,29 - 0,00	< 0,29 - 0,00
5		

How are reference conditions, H/G and G/M boundaries derived?

The reference is based on (few) existing reference sites. For macrophyte assessment the classification of the RI values into the categories of ecological status is proved in Table 5.

How well correlate the indicators with pressure indicators?

The German assessment metrics are correlating quite well with eutrophication indicating parameters (SRP and Secchi depth). Figure 1 shows as an example the correlation of the macrophyte assessment with SRP.

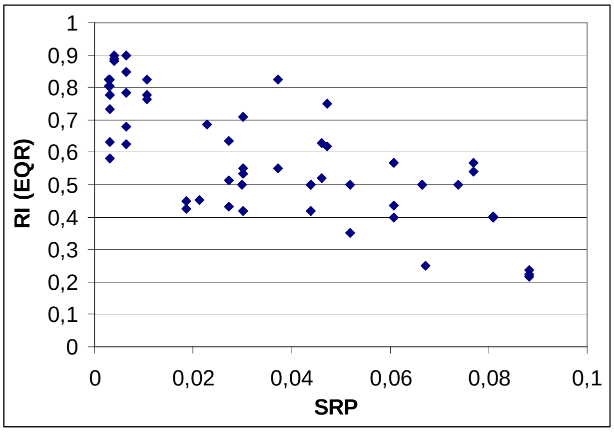


Fig 1. Correlation between German EQR for macrophyte assessment and SRP concentration in German LCB 1 type lakes.

How is dealt with differences between national data and assessment vs. GIG data and assessment?

<u>Completeness of method</u>

The German macrophyte assessment method uses a combination of metrics (Table 9):

Table 9: metrics used for German method

metric	**data requirements**	**used for intercalibratio**
macrophyte abundance	5 level scale	yes, but only on 3 level scale
depth distribution of macrophytes	macrophytes recorded by 4 depth classes (see Annex A)	no, all taxa are treated equal no matter in which depth they occur (see Annex B)
dominant stands of *Ceratophyllum demersum, C. submersum, Elodea canadensis/ nuttallii, Myriophyllum spicatum, Najas marina subsp. intermedia* or *Potamogeton pectinatus*	abundance data on 1 to 5 scale	yes, possible with the second transformation approach (see below)
vegetation limit	depth of lowest macrophyte stands	no, information not provided in GIG data

<u>Data transformation to GIG data base</u>
The abundance data on the 3 level scale needed to be transformed to better fit the ranges of the German 5 level scale (Table 10). This is important, because prior to further calculations the nominally scaled values of plant abundance are converted into metric quantities using the following function: macrophyte abundance^3 = quantity

Table 10. Adaptation of abundance classes for assessment.

GIG data abundance scale	Adaptation for assessment – first approach –	Adaptation for assessment – second approach –
1	2	1
2	3	3
3	4	5

The first approach led to an underestimation of abundant species. As a result dominant stands of certain taxa (e.g. *Ceratophyllum demersum*) that are used as an correcting factor in the German method could not be detected.

<u>Assessment transformation to the GIG data base</u>

Depth distribution
Taxa are assigned to indicator groups A (reference taxa) B (indifferent taxa) and C (disturbance indicators). Many species are treated different for growing in different depth

zones. So the indicator value for most species is improving the deeper they grow. Table 11 gives an example.

Table 11: Species groups for Chara contraria in lake type Tkp (= LCB2) according to depth classes

Depth class	Species group
0-1 m	B
1-2 m	A
2-4 m	A
> 4 m	A

For intercalibration the original table (Annex A) had to be reduced to only one species group per taxon (Annex B). These species groups were derived by the most common indicator group in the original table (e.g. Chara contraria: "A"). If the species groups were even (e.g. two times "B" and two times "C") the resulting Group was "B" (= indifferent species).

Vegetation limit

The depth of the lowest macrophyte stands is used as an additional metric to correct EQR values. If the vegetation does not reach a requested depth (e.g. 3 m in TKp/LCB2 Lakes) the assessment is downgraded by one ecological quality class.
As the GIG data provides no information about vegetation limit the German assessment seems to be less strict than it is.

Effects on final results

Fig 2 shows how important the information about vegetation limit and depth distribution are for the final macrophytes assessment. If the information about vegetation limit is missing, 12 of the 58 classifications (21 %) are one quality class better than with the original dataEspecially lower EQR values (0.5 and below) are affected.

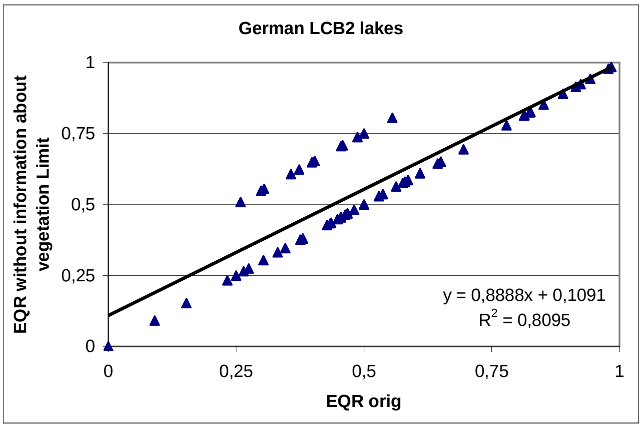


Fig 2. Correlation between German EQR for macrophyte assessment based on original data and without information about vegetation limit for German LCB 2 type lakes

Transformations on national methodology
Not needed.

ANNEX A. Original list of type specific indicator species. The table continues at the next pages.

Taxon	TKg10	TKg13	TKp
Butomus umbellatus	B	B	B
Callitriche hermaphroditica	B	B	B
Ceratophyllum demersum 0-1m	C	C	C
Ceratophyllum demersum >1m	B	B	B
Ceratophyllum submersum			B
Chara aspera	A	A	A
Chara contraria 0-1m	B	B	B
Chara contraria 1-2m	B	B	A
Chara contraria 2-4m	A	A	A
Chara contraria >4m	A	A	A
Chara delicatula 0-1m	B	B	B
Chara delicatula 1-2m	B	B	A
Chara delicatula >2m	A	A	A
Chara filiformis	A	A	A
Chara globularis 0-1m	B	B	B
Chara globularis 1-2m	B	B	A
Chara globularis 2-4m	A	B	A
Chara globularis >4m	A	A	A
Chara hispida	A	A	A
Chara intermedia	A	A	A
Chara polyacantha	A	A	A
Chara rudis	A	A	A
Chara tomentosa	A	A	A
Chara vulgaris	B	B	A
Elatine hexandra	A	A	A
Elatine hydropiper	A	A	A
Elatine triandra	A	A	A
Eleocharis acicularis	B	B	B
Elodea canadensis 0-1m	C	C	C
Elodea canadensis 1-4m	C	C	B
Elodea canadensis >4m	B	B	B
Elodea nuttallii 0-1m	C	C	C
Elodea nuttallii 1-4m	C	C	B
Elodea nuttallii >4 m	C	C	B
Fontinalis antipyretica 0-1m	B	B	B
Fontinalis antipyretica 1-4m	B	B	A
Fontinalis antipyretica >4m	A	A	A
Hippuris vulgaris	B	B	B
Lemna minor	C	C	B
Lemna trisulca 0-2 m	C	C	B
Lemna trisulca 2-4 m	B	C	B
Lemna trisulca > 4 m	B	B	B
Littorella uniflora	A	A	A
Myriophyllum alterniflorum 0-1m	A	A	A
Myriophyllum alterniflorum >1m	A	A	A
Myriophyllum spicatum 0-2m	B	B	B
Myriophyllum spicatum >2 m	B	B	B
Myriophyllum verticillatum 0-1m	B	B	A
Myriophyllum verticillatum 1-2m	A	B	A
Myriophyllum verticillatum >2m	A	B	A
Najas intermedia 0-2m	B	B	B
Najas intermedia 2-4m	B	B	A
Najas intermedia >4m	A	B	A
Najas marina 0-2m	C	C	C
Najas marina 2-4m	C	C	C
Najas marina >4m	C	C	C
Nitella capillaris	A	A	A
Nitella flexilis 0-2m	B	B	A
Nitella flexilis 2-4m	A	B	A
Nitella flexilis >4m	A	A	A
Nitella gracilis	A	A	A
Nitella mucronata 0-2m	B	B	A
Nitella mucronata 2-4m	A	B	A
Nitella mucronata >4m	A	A	A
Nitella opaca 0-1 m	A	B	A
Nitella opaca > 1 m	A	A	A
Nitella syncarpa	A	A	A
Nitellopsis obtusa 0-2m	B	B	B

Nitellopsis obtusa 2-4m	A	B	A
Nitellopsis obtusa >4m	A	A	A
Nuphar lutea	B	B	B
Nymphaea alba	B	B	B
Nymphoides peltatus	B	B	B
Potamogeton acutifolius 0-2 m	B	B	A
Potamogeton acutifolius >2 m	A	A	A
Potamogeton alpinus	A	A	A
Potamogeton berchtoldii 0-2m	B	B	B
Potamogeton berchtoldii 2-4m	A	B	A
Potamogeton berchtoldii >4m	A	A	A
Potamogeton compressus	A	B	A
Potamogeton crispus x perfoliatus	B	B	B
Potamogeton crispus 0-1m	C	C	C
Potamogeton crispus 1-4m	C	C	B
Potamogeton crispus >4m	B	B	B
Potamogeton filiformis	A	A	A
Potamogeton friesii 0-2m	B	C	B
Potamogeton friesii 2-4m	B	B	A
Potamogeton friesii >4m	A	B	A
Potamogeton gramineus	A	A	A
Potamogeton lucens 0-1m	B	B	B
Potamogeton lucens 1-2m	B	B	A
Potamogeton lucens 2-4m	A	B	A
Potamogeton lucens >4m	A	A	A
Potamogeton nodosus	B	C	B
Potamogeton obtusifolius	B	B	B
Potamogeton natans	A	A	A
Potamogeton pectinatus 0-4 m	B	B	B
Potamogeton pectinatus >4 m	B	B	B
Potamogeton perfoliatus	B	B	B
Potamogeton praelongus	A	A	A
Potamogeton pusillus 0-1m	B	C	B
Potamogeton pusillus 1-2m	B	B	B
Potamogeton pusillus 2-4m	B	B	B
Potamogeton pusillus >4m	A	B	B
Potamogeton rutilus	A	A	A
Potamogeton trichoides 0-1m	B	B	B
Potamogeton trichoides 1-2m	A	B	A
Potamogeton trichoides >2m	A	A	A
Potamogeton x nitens	A	B	A
Potamogeton x zizii	A	A	A
Ranunculus circinatus 0-1m	C	C	C
Ranunculus circinatus 1-2m	B	C	B
Ranunculus circinatus 2-4 m	B	C	B
Ranunculus circinatus >4 m	B	B	B
Ranunculus peltatus	B	B	A
Ranunculus trichophyllus	B	B	A
Sagittaria sagittifolia (flutend)	C	C	B
Schoenoplectus lacustris (flutend)	B	B	B
Sparganium emersum (flutend)	B	B	B
Spirodela polyrhiza	C	C	B
Stratiotes aloides	A	A	A
Tolypella glomerata 0-2 m	A	B	A
Tolypella glomerata 2-4 m	A	A	A
Tolypella glomerata > 4 m	A	A	A
Utricularia australis 0-2 m	B	B	A
Utricularia australis 2-4 m	A	B	A
Utricularia australis > 4 m	A	A	A
Utricularia intermedia	A	A	A
Utricularia minor	A		
Utricularia vulgaris 0-1m	B	B	A
Utricularia vulgaris 1-4m	A	B	A
Utricularia vulgaris >4m	A	A	A
Zannichellia palustris 0-1m	C	C	C
Zannichellia palustris 1-2m	C	C	B
Zannichellia palustris >2 m	B	B	B

ANNEX B. List of type specific indicator species –modified for intercalibration. The table continues at the next pages.

	TKg10	TKg13	TKp
Callitriche hermaphroditica	b	b	b
Ceratophyllum demersum	b	b	b
Ceratophyllum submersum			b
Chara aspera	a	a	a
Chara contraria	b	b	a
Chara delicatula	b	b	a
Chara filiformis	a	a	a
Chara fragilis	b	b	a
Chara globularis	b	b	a
Chara hispida	a	a	a
Chara intermedia	a	a	a
Chara rudis	a	a	a
Chara tomentosa	a	a	a
Chara vulgaris	b	b	a
Elatine hexandra	a	a	a
Elatine hydropiper	a	a	a
Elatine triandra	a	a	a
Eleocharis acicularis	b	b	b
Elodea canadensis	c	c	c
Elodea nuttallii	c	c	c
Lemna minor	c	c	b
Lemna trisulca	b	c	b
Littorella uniflora	a	a	a
Myriophyllum alterniflorum	a	a	a
Myriophyllum spicatum	b	b	b
Myriophyllum verticillatum	a	b	a
Najas intermedia	b	b	a
Najas marina	c	c	c
Nitella flexilis	b	b	a
Nitella mucronata	b	b	a
Nitella opaca	a	a	a
Nitella syncarpa	a	a	a
Nitellopsis obtusa	b	b	b
Nuphar lutea	b	b	b
Nymphaea alba	b	b	b
Nymphoides peltatus	b	b	b
Potamogeton acutifolius	b	b	a
Potamogeton alpinus	a	a	a
Potamogeton berchtoldii	b	b	b
Potamogeton compressus	a	b	a
Potamogeton crispus	c	c	b
Potamogeton filiformis	a	a	a
Potamogeton friesii	b	b	b
Potamogeton gramineus	a	a	a
Potamogeton lucens	b	b	a
Potamogeton natans	a	a	a
Potamogeton obtusifolius	b	b	b
Potamogeton pectinatus	b	b	b
Potamogeton perfoliatus	b	b	b
Potamogeton praelongus	a	a	a
Potamogeton pusillus	b	b	b
Potamogeton rutilus	a	a	a
Potamogeton trichoides	a	b	a
Potamogeton x zizii	a	a	a
Ranunculus circinatus	b	c	b
Ranunculus peltatus	b	b	a
Ranunculus trichophyllus	b	b	a
Sagittaria sagittifolia (nat)	c	c	b
Spirodela polyrhiza	c	c	b
Stratiotes aloides	a	a	a
Tolypella glomerata	a	b	a
Utricularia australis	b	b	a
Utricularia intermedia	a	a	a
Utricularia vulgaris	a	b	a
Zannichellia palustris	b	b	b

ANNEX C:Indicative species of the Trophic Index according to Schönfelder et al. (unpublished), modified TI_{Nord}. The table continues at the next pages.

Taxon	Trophic
Achnanthes	
- altaica (PORETZKY) CLEVE-EULER	0,38
- clevei GRUNOW	2,25
- clevei var. rostrata	0,00
- conspicua A.MAYER	2,62
- daonensis LANGE-BERTALOT	0,98
- daui FOGED	0,98
- delicatula (KUETZING) GRUNOW	5,43
- didyma HUSTEDT	0,48
- exigua GRUNOW	2,41
- exilis KUETZING	0,00
- flexella (KUETZING) BRUN	0,02
- flexella var. alpestris BRUN	0,54
- helvetica (HUSTEDT) LANGE-BERTALOT	0,48
- holsatica HUSTEDT	1,70
- hungarica (GRUNOW) GRUNOW	6,67
- joursacense HERIBAUD	1,96
- kolbei HUSTEDT	4,12
- kranzii LANGE-BERTALOT	0,48
- kuelbsii LANGE-BERTALOT	0,48
- lacus-vulcani LANGE-BERTALOT & KRAMMER	0,48
- laevis OESTRUP	0,52
- lanceolata ssp. frequentissima LANGE-BERTALOT	2,28
- lanceolata ssp. lanceolata (BREBISSON) GRUNOW	1,15
- lapidosa KRASSKE	0,66
- laterostrata HUSTEDT	0,48
- lauenburgiana HUSTEDT	4,23
- levanderi HUSTEDT	0,38
- marginulata GRUNOW	0,48
- minuscula HUSTEDT	3,04
- minutissima var. affinis (GRUNOW) LANGE-BERTALOT	3,38
- minutissima var. gracillima (MEISTER) LANGE-BERTALOT	0,38
- minutissima var. scotica (CARTER) LANGE-BERTALOT	0,14
- oblongella OESTRUP	0,48
- oestrupii (CLEVE-EULER) HUSTEDT	1,55
- petersenii HUSTEDT	0,66
- ploenensis HUSTEDT	4,23
- pseudoswazi CARTER	0,48
- pusilla (GRUNOW) DE TONI	0,75
- rechtensis LECLERCQ	0,38
- rosenstockii LANGE-BERTALOT	0,09
- rossii HUSTEDT	0,48
- silvahercynia LANGE-BERTALOT	0,48
- straubiana LANGE-BERTALOT	0,00
- subatomoides (HUSTEDT) LANGE-BERTALOT & ARCHIBALD	0,66
- trinodis (W.SMITH) GRUNOW	0,43
- ventralis (KRASSKE) LANGE-BERTALOT	0,48
- ziegleri LANGE-BERTALOT	1,72
Amphipleura	
- pellucida (KUETZING) KUETZING	1,21
Amphora	
- fogediana KRAMMER	0,90
- inariensis KRAMMER	0,98
- libyca EHRENBERG	3,96
- ovalis (KUETZING) KUETZING	3,26
- pediculus (KUETZING) GRUNOW	2,89
- thumensis (A.MAYER) CLEVE-EULER	0,38
- veneta KUETZING	5,70
- veneta var. capitata HAWORTH	0,77
Anomoeoneis	
- sphaerophora (EHRENBERG) PFITZER	5,30
Brachysira	
- brebissonii ROSS	0,48
- calcicola LANGE-BERTALOT	0,38
- hofmanniae LANGE-BERTALOT	0,38
- liliana LANGE-BERTALOT	0,38
- neoexilis LANGE-BERTALOT	0,74

Taxon	Trophic
- procera LANGE-BERTALOT & MOSER	0,38
- serians (BREBISSON) ROUND & MANN	0,38
- styriaca (GRUNOW) ROSS	0,40
- vitrea (GRUNOW) ROSS	0,48
- zellensis (GRUNOW) ROUND & MANN	0,38
Caloneis	
- aerophila BOCK	0,48
- alpestris (GRUNOW) CLEVE	0,40
- amphisbaena (BORY DE SAINT VINCENT) CLEVE	4,05
- bacillum (GRUNOW) CLEVE	3,21
- latiuscula (KUETZING) CLEVE	0,38
- obtusa (W.SMITH) CLEVE	0,38
- schumanniana (GRUNOW) CLEVE	1,86
- silicula (EHRENBERG) CLEVE	3,25
- tenuis (GREGORY) KRAMMER	0,78
Cocconeis	
- disculus (SCHUMANN) CLEVE	2,02
- neothumensis KRAMMER	2,15
- pediculus EHRENBERG	4,33
- placentula EHRENBERG	3,45
- placentula var. lineata (EHRENBERG) VAN HEURCK	2,93
- placentula var. pseudolineata GEITLER	3,45
Cymatopleura	
- elliptica (BREBISSON) W.SMITH	3,33
- solea (BREBISSON) W.SMITH	4,08
Cymbella	
- affinis KUETZING	1,09
- alpina GRUNOW	0,38
- amphicephala NAEGELI	1,41
- amphicephala var. hercynica (SCHMIDT) CLEVE	0,00
- ancyli CLEVE	1,14
- angustata (W.SMITH) CLEVE	0,00
- aspera (EHRENBERG) CLEVE	2,58
- austriaca GRUNOW	0,54
- caespitosa (KUETZING) BRUN	1,55
- cesatii (RABENHORST) GRUNOW	0,45
- cistula (EHRENBERG) KIRCHNER	2,56
- cuspidata KUETZING	0,77
- cymbiformis J.G.AGARDH	0,71
- delicatula KUETZING	0,48
- descripta (HUSTEDT) KRAMMER & LANGE-BERTALOT	0,38
- ehrenbergii KUETZING	2,36
- elginensis KRAMMER	0,38
- falaisensis (GRUNOW) KRAMMER & LANGE-BERTALOT	0,68
- gaeumannii MEISTER	0,48
- gracilis (EHRENBERG) KUETZING	0,97
- hebridica (GRUNOW) CLEVE	0,48
- helvetica KUETZING	0,50
- helvetica var. compacta (OESTRUP) HUSTEDT	3,04
- hustedtii KRASSKE	1,47
- hybrida GRUNOW	0,40
- incerta (GRUNOW) CLEVE	0,40
- lacustris (J.G.AGARDH) CLEVE	0,04
- laevis NAEGELI	0,62
- lanceolata (EHRENBERG) KIRCHNER	3,60
- lapponica GRUNOW	0,66
- lata GRUNOW	1,51
- leptoceros (EHRENBERG) KUETZING	0,95
- mesiana CHOLNOKY	0,48
- microcephala GRUNOW	1,02
- minuta HILSE	0,70
- norvegica GRUNOW	0,48
- perpusilla CLEVE-EULER	0,48
- prostrata (BERKELEY) CLEVE	3,39
- reichardtii KRAMMER	3,97
- schimanskii KRAMMER	0,38
- simonsenii KRAMMER	0,48
- sinuata GREGORY	2,79
- stauroneiformis LAGERSTEDT	0,48

Taxon	Trophic
- subaequalis GRUNOW	0,83
- subcuspidata KRAMMER	2,14
- tumida (BREBISSON) VAN HEURCK	4,49
- tumidula GRUNOW	0,48
- tumidula var. lancettula KRAMMER	0,48
Denticula	
- kuetzingii GRUNOW	0,97
- tenuis KUETZING	0,80
Diatoma	
- anceps (EHRENBERG) KIRCHNER	0,66
- ehrenbergii KUETZING	0,00
- hyemalis (ROTH) HEIBERG	0,48
- mesodon (EHRENBERG) KUETZING	0,66
- problematica LANGE-BERTALOT	5,74
- tenuis J.G.AGARDH	4,97
- vulgaris BORY DE SAINT VINCENT	5,61
Diploneis	
- elliptica (KUETZING) CLEVE	1,44
- modica HUSTEDT	0,02
- oblongella (NAEGELI) CLEVE-EULER	0,30
- ovalis (HILSE) CLEVE	0,44
- petersenii HUSTEDT	0,66
- subconstricta	0,00
Ellerbeckia	
- arenaria (MOORE) CRAWFORD	3,17
Epithemia	
- adnata (KUETZING) BREBISSON	2,42
- smithii CARRUTHERS	0,00
- sorex KUETZING	2,46
- turgida (EHRENBERG) KUETZING	2,95
Eunotia	
- arcubus NOERPEL & LANGE-BERTALOT	0,62
- bilunaris (EHRENBERG) MILLS	3,66
- botuliformis WILD et al.	1,61
- diodon EHRENBERG	0,48
- exigua (BREBISSON) RABENHORST	0,64
- faba EHRENBERG	0,42
- fallax A.CLEVE	0,38
- flexuosa (BREBISSON) KUETZING	0,48
- formica EHRENBERG	5,86
- glacialis MEISTER	1,81
- hexaglyphis EHRENBERG	0,38
- implicata NOERPEL et al.	1,11
- incisa GREGORY	1,02
- meisteri HUSTEDT	0,38
- muscicola var. tridentula NOERPEL & LANGE-BERTALOT	0,48
- naegelii MIGULA	1,07
- nymanniana GRUNOW	0,38
- pectinalis (DILLWYN) RABENHORST	0,48
- praerupta EHRENBERG	0,48
- praerupta var. bigibba (KUETZING) GRUNOW	0,48
- rhomboidea HUSTEDT	0,48
- septentrionalis OESTRUP	0,38
- serra EHRENBERG	0,38
- serra var. diadema (EHRENBERG) PATRICK	0,38
- serra var. tetraodon (EHRENBERG) NOERPEL	0,38
- silvahercynia NOERPEL et al.	0,38
- sudetica O.MUELLER	0,38
- tenella (GRUNOW) HUSTEDT	0,48
Fragilaria	
- acidoclinata LANGE-BERTALOT & HOFMANN	0,48
- berolinensis (LEMMERMANN) LANGE-BERTALOT	2,28
- bidens HEIBERG	6,87
- brevistriata GRUNOW	2,81
- capucina DESMAZIERES	3,79
- capucina distans - Sippen KRAMMER & LANGE-BERTALOT	0,38
- capucina var. amphicephala (GRUNOW) LANGE-BERTALOT	0,51
- capucina var. austriaca (GRUNOW) LANGE-BERTALOT	0,98
- capucina var. mesolepta (RABENHORST) RABENHORST	3,82

Taxon	Trophic
- capucina var. rumpens (KUETZING) LANGE-BERTALOT	4,12
- capucina var. vaucheriae (KUETZING) LANGE-BERTALOT	5,33
- cyclopum (BRUTSCHY) LANGE-BERTALOT	2,04
- delicatissima (W.SMITH) LANGE-BERTALOT	0,90
- exigua GRUNOW	0,48
- famelica (KUETZING) LANGE-BERTALOT	4,23
- fasciculata (J.G.AGARDH) LANGE-BERTALOT	5,66
- incognita REICHARDT	1,34
- lapponica GRUNOW	2,50
- leptostauron var. dubia (GRUNOW) HUSTEDT	4,18
- leptostauron var. martyi (HERIBAUD) LANGE-BERTALOT	3,98
- nanana LANGE-BERTALOT	1,57
- nitzschioides GRUNOW	5,66
- parasitica (W.SMITH) GRUNOW	3,28
- parasitica var. subconstricta GRUNOW	4,83
- pinnata EHRENBERG	2,57
- pulchella (RALFS) LANGE-BERTALOT	5,92
- robusta (FUSEY) MANGUIN	1,51
- tenera (W.SMITH) LANGE-BERTALOT	1,89
- ulna (NITZSCH) LANGE-BERTALOT	5,27
- ulna angustissima - Sippen KRAMMER & LANGE-BERTALOT	5,74
- ulna var. acus (KUETZING) LANGE-BERTALOT	3,78
- virescens RALFS	0,66
Frustulia	
- rhomboides (EHRENBERG) DE TONI	1,00
- rhomboides var. crassinervia (BREBISSON) ROSS	0,48
- rhomboides var. saxonica (RABENHORST) DE TONI	0,48
- vulgaris (THWAITES) DE TONI	5,71
Gomphonema	
- acuminatum EHRENBERG	3,31
- acutiusculum (O.MUELLER) CLEVE-EULER	0,48
- angustum J.G.AGARDH	0,76
- augur EHRENBERG	4,99
- auritum A.BRAUN	0,27
- bavaricum REICHARDT & LANGE-BERTALOT	0,48
- bohemicum REICHELT & FRICKE	0,48
- clavatum EHRENBERG	4,00
- dichotomum KUETZING	0,61
- gracile EHRENBERG	1,35
- hebridense GREGORY	0,23
- helveticum BRUN	0,40
- insigne GREGORY	5,37
- lagerheimii A.CLEVE	0,48
- lateripunctatum REICHARDT & LANGE-BERTALOT	0,25
- micropus KUETZING	6,49
- minutum (J.G.AGARDH) J.G.AGARDH	4,23
- occultum REICHARDT & LANGE-BERTALOT	0,57
- olivaceum (HORNEMANN) BREBISSON	4,30
- olivaceum var. minutissimum HUSTEDT	0,98
- olivaceum var. olivaceoides (HUSTEDT) LANGE-BERTALOT &	0,98
- olivaceum var. olivaceolacuum LANGE-BERTALOT &	4,23
- parvulum (KUETZING) KUETZING	2,95
- parvulum var. exilissimum GRUNOW	0,98
- parvulum var. parvulius LANGE-BERTALOT & REICHARDT	0,48
- procerum REICHARDT & LANGE-BERTALOT	0,66
- productum (GRUNOW) LANGE-BERTALOT & REICHARDT	0,98
- pseudotenellum LANGE-BERTALOT	0,66
- pumilum (GRUNOW) LANGE-BERTALOT & REICHARDT	2,75
- sarcophagus GREGORY	7,76
- subtile EHRENBERG	0,13
- tenue FRICKE	0,43
- tergestinum FRICKE	3,04
- truncatum EHRENBERG	3,25
- vibrio EHRENBERG	0,77
Gyrosigma	
- attenuatum (KUETZING) RABENHORST	3,62
- nodiferum (GRUNOW) REIMER	4,40
Mastogloia	
- baltica GRUNOW	0,00

Taxon	Trophic
- elliptica J.G.AGARDH	0,00
- grevillei W.SMITH	0,00
- smithii THWAITES	0,37
- smithii var. lacustris GRUNOW	0,43
Melosira	
- varians J.G.AGARDH	4,89
Meridion	
- circulare (GREVILLE) J.G.AGARDH	4,92
Navicula	
- abiskoensis HUSTEDT	0,48
- absoluta HUSTEDT	0,60
- atomus (KUETZING) GRUNOW	4,74
- atomus var. permitis (HUSTEDT) LANGE-BERTALOT	5,74
- bacillum EHRENBERG	2,48
- brockmannii HUSTEDT	0,38
- bryophila PETERSEN	0,52
- capitata EHRENBERG	5,37
- capitata var. hungarica (GRUNOW) ROSS	5,37
- capitata var. lueneburgensis (GRUNOW) PATRICK	4,59
- capitatoradiata GERMAIN	4,20
- cari EHRENBERG	3,06
- cariocincta	2,20
- cincta (EHRENBERG) RALFS	2,20
- citrus KRASSKE	5,74
- clementioides HUSTEDT	2,00
- clementis GRUNOW	2,72
- cocconeiformis GREGORY	0,66
- concentrica CARTER	0,40
- constans HUSTEDT	3,04
- costulata GRUNOW	5,86
- cryptocephala KUETZING	3,00
- cryptofallax LANGE-BERTALOT & HOFMANN	4,23
- cryptotenelloides LANGE-BERTALOT	1,37
- cuspidata (KUETZING) KUETZING	4,85
- dealpina LANGE-BERTALOT	0,48
- decussis OESTRUP	3,02
- densilineolata (LANGE-BERTALOT) LANGE-BERTALOT	0,62
- detenta HUSTEDT	0,48
- diluviana KRASSKE	0,23
- elginensis (GREGORY) RALFS	2,50
- erifuga LANGE-BERTALOT	5,74
- exilis KUETZING	0,66
- explanata HUSTEDT	0,60
- festiva KRASSKE	0,48
- gallica var. perpusilla (GRUNOW) LANGE-BERTALOT	0,48
- gastrum (EHRENBERG) KUETZING	3,57
- goeppertiana (BLEISCH) H.L.SMITH	5,74
- gotlandica GRUNOW	0,22
- gregaria DONKIN	6,76
- halophila (GRUNOW) CLEVE	5,75
- heimansioides LANGE-BERTALOT	0,48
- helensis SCHULZ	0,70
- hustedtii KRASSKE	4,23
- integra (W.SMITH) RALFS	4,23
- jaagii MEISTER	0,38
- jaernefeltii HUSTEDT	0,98
- jentzschii GRUNOW	1,60
- joubaudii GERMAIN	3,04
- krasskei HUSTEDT	0,38
- laevissima KUETZING	2,32
- lanceolata (J.G.AGARDH) EHRENBERG	7,05
- laterostrata HUSTEDT	1,09
- leistikowii LANGE-BERTALOT	0,66
- lenzii HUSTEDT	0,83
- leptostriata JOERGENSEN	0,48
- libonensis SCHOEMAN	5,74
- mediocris KRASSKE	0,48
- menisculus SCHUMANN	4,67
- menisculus var. grunowii LANGE-BERTALOT	3,04

Taxon	Trophic
- menisculus var. upsaliensis GRUNOW	4,00
- minuscula var. muralis (GRUNOW) LANGE-BERTALOT	5,74
- minusculoides HUSTEDT	5,74
- molestiformis HUSTEDT	5,74
- monoculata HUSTEDT	5,74
- naumannii HUSTEDT	0,38
- notha WALLACE	0,66
- oblonga KUETZING	2,02
- oligotraphenta LANGE-BERTALOT & HOFMANN	0,11
- oppugnata HUSTEDT	4,62
- placentula (EHRENBERG) GRUNOW	2,64
- porifera HUSTEDT	2,70
- porifera var. opportuna (HUSTEDT) LANGE-BERTALOT	0,48
- praeterita HUSTEDT	0,41
- protracta (GRUNOW) CLEVE	3,23
- pseudanglica LANGE-BERTALOT	3,13
- pseudobryophila (HUSTEDT) HUSTEDT	0,48
- pseudolanceolata LANGE-BERTALOT	3,24
- pseudoscutiformis HUSTEDT	0,42
- pseudotuscula HUSTEDT	1,12
- pseudoventralis HUSTEDT	2,63
- pupula KUETZING	3,01
- pygmaea KUETZING	4,23
- radiosa KUETZING	1,90
- recens (LANGE-BERTALOT) LANGE-BERTALOT	5,74
- reichardtiana LANGE-BERTALOT	3,51
- reinhardtii GRUNOW	3,31
- rhynchotella LANGE-BERTALOT	5,74
- rotunda HUSTEDT	2,90
- saprophila LANGE-BERTALOT	5,74
- schadei KRASSKE	0,66
- schmassmannii HUSTEDT	0,48
- schoenfeldii HUSTEDT	2,71
- schroeterii MEISTER	5,74
- scutelloides W.SMITH	3,91
- seibigiana LANGE-BERTALOT	2,83
- seminulum GRUNOW	5,70
- slesvicensis GRUNOW	4,65
- soehrensis KRASSKE	0,48
- soehrensis var. hassiaca (KRASSKE) LANGE-BERTALOT	0,48
- soehrensis var. muscicola (PETERSEN) KRASSKE	0,48
- splendicula VAN LANDINGHAM	4,23
- striolata (GRUNOW) LANGE-BERTALOT	2,36
- stroemii HUSTEDT	0,72
- subalpina REICHARDT	0,54
- subhamulata GRUNOW	1,17
- sublucidula HUSTEDT	4,23
- subminuscula MANGUIN	5,74
- submolesta HUSTEDT	0,48
- subplacentula HUSTEDT	2,10
- subrotundata HUSTEDT	2,43
- subtilissima CLEVE	0,48
- suchlandtii HUSTEDT	0,48
- tridentula KRASSKE	0,48
- tripunctata (O.F.MUELLER) BORY DE SAINT VINCENT	5,31
- trivialis LANGE-BERTALOT	4,92
- trophicatrix LANGE-BERTALOT	2,62
- tuscula (EHRENBERG) GRUNOW	1,17
- tuscula f. minor KRAMMER & LANGE-BERTALOT	1,36
- variostriata KRASSKE	0,48
- viridula var. rostellata (KUETZING) CLEVE	5,74
- viridulacalcis	0,50
- vitabunda HUSTEDT	1,09
- vulpina KUETZING	0,71
- wildii LANGE-BERTALOT	0,43
Neidium	
- affine (EHRENBERG) PFITZER	0,48
- alpinum HUSTEDT	0,48
- ampliatum (EHRENBERG) KRAMMER	0,92

Taxon	Trophic
- bisulcatum (LAGERSTEDT) CLEVE	0,48
- dubium (EHRENBERG) CLEVE	2,20
- iridis (EHRENBERG) CLEVE	0,48
Nitzschia	
- acicularis (KUETZING) W.SMITH	5,83
- acidoclinata LANGE-BERTALOT	2,85
- acula HANTZSCH	5,74
- agnita HUSTEDT	5,56
- alpina HUSTEDT	0,48
- amphibia GRUNOW	4,99
- amphibia var. frauenfeldii	1,27
- angustata (W.SMITH) GRUNOW	1,76
- angustatula LANGE-BERTALOT	2,84
- bacilliformis HUSTEDT	0,54
- bacillum HUSTEDT	1,34
- calida GRUNOW	5,74
- capitellata HUSTEDT	7,29
- communis RABENHORST	5,74
- commutata GRUNOW	9,72
- constricta (KUETZING) RALFS	6,72
- dealpina LANGE-BERTALOT & HOFMANN	0,98
- debilis ARNOTT	5,74
- dissipata (KUETZING) GRUNOW	3,92
- dissipata ssp. oligotraphenta LANGE-BERTALOT	1,07
- dissipata var. media (HANTZSCH) GRUNOW	2,91
- diversa HUSTEDT	0,71
- fibulafissa LANGE-BERTALOT	0,66
- filiformis (W.SMITH) VAN HEURCK	5,74
- fonticola GRUNOW	3,72
- fossilis (GRUNOW) GRUNOW	3,65
- gessneri HUSTEDT	0,62
- gisela LANGE-BERTALOT	0,45
- heufleriana GRUNOW	2,78
- homburgiensis LANGE-BERTALOT	0,98
- hungarica GRUNOW	5,74
- inconspicua GRUNOW	5,74
- intermedia HANTZSCH	5,74
- lacuum LANGE-BERTALOT	1,27
- levidensis var. salinarum GRUNOW	8,08
- linearis (J.G.AGARDH) W.SMITH	4,77
- linearis var. subtilis (GRUNOW) HUSTEDT	5,74
- linearis var. tenuis (W.SMITH) GRUNOW	5,74
- microcephala GRUNOW	5,74
- palea (KUETZING) W.SMITH	3,05
- paleacea GRUNOW	3,50
- pusilla GRUNOW	5,74
- radicula HUSTEDT	0,98
- regula HUSTEDT	0,43
- sigmoidea (NITZSCH) W.SMITH	3,40
- sociabilis HUSTEDT	4,23
- solita HUSTEDT	5,74
- subacicularis HUSTEDT	3,49
- supralitorea LANGE-BERTALOT	5,74
- tryblionella HANTZSCH	5,74
- umbonata (EHRENBERG) LANGE-BERTALOT	5,74
- valdecostata LANGE-BERTALOT & SIMONSEN	6,34
- valdestriata ALEEM & HUSTEDT	3,04
- wuellerstorffii LANGE-BERTALOT	5,74
Peronia	
- fibula (BREBISSON) ROSS	0,48
Pinnularia	
- anglica KRAMMER	0,87
- appendiculata (J.G.AGARDH) CLEVE	5,88
- borealis EHRENBERG	2,95
- legumen EHRENBERG	1,76
- mesolepta (EHRENBERG) W.SMITH	2,02
- microstauron (EHRENBERG) CLEVE	2,41
- neomajor KRAMMER	0,48
- nobilis (EHRENBERG) EHRENBERG	4,06

Taxon	Trophic
- nodosa (EHRENBERG) W.SMITH	1,72
- polyonca (BREBISSON) W.SMITH	1,23
- rupestris HANTZSCH	2,91
- silvatica PETERSEN	0,48
- subcapitata GREGORY	0,94
- subcapitata var. hilseana (JANISCH) O.MUELLER	0,48
- subgibba KRAMMER	2,16
- subrupestris KRAMMER	4,18
- viridiformis KRAMMER	2,91
Rhoicosphenia	
- abbreviata (J.G.AGARDH) LANGE-BERTALOT	4,35
Rhopalodia	
- gibba (EHRENBERG) O.MUELLER	2,81
- gibba var. parallela (GRUNOW) H.ET M.PERAGALLO	0,54
Simonsenia	
- delognei (GRUNOW) LANGE-BERTALOT	4,23
Stauroneis	
- anceps EHRENBERG	1,72
- borrichii (PETERSEN) LUND	0,48
- kriegerii PATRICK	3,84
- phoenicenteron (NITZSCH) EHRENBERG	1,27
- siberica	0,00
- smithii GRUNOW	3,04
- undata HUSTEDT	0,48
Stenopterobia	
- curvula (W.SMITH) KRAMMER	0,48
- delicatissima (LEWIS) BREBISSON	0,48
- densestriata (HUSTEDT) KRAMMER	0,48
Surirella	
- angusta KUETZING	7,05
- bifrons EHRENBERG	2,42
- brebissonii KRAMMER & LANGE-BERTALOT	6,83
- linearis W.SMITH	1,69
- linearis f. constricta	0,48
- minuta BREBISSON	5,74
- roba LECLERCQ	0,66
Tabellaria	
- flocculosa (ROTH) KUETZING	1,13
- ventricosa KUETZING	0,38

ANNEX D: : Species groups A, and C in the biocoenotic lake types of the North German Lowland. The table continues at the next pages.

DV-Nr	Taxon	13.1	13.2	10.1	11	10.2	12
6835	Achnanthes bioretii	C	C	C		A	A
6248	Achnanthes delicatula	C	C	C	C		
16112	Achnanthes delicatula ssp. engelbrechtii	C	C	C	C	C	
6249	Achnanthes exilis	A	A	A	A	A	A
6250	Achnanthes flexella	A	A	A	A	A	A
6251	Achnanthes flexella var. alpestris	A	A	A	A	A	A
16585	Achnanthes grana	C	C	C	C	C	
6047	Achnanthes hungarica	C	C	C	C	C	
6703	Achnanthes kolbei	C	C	C			
6258	Achnanthes laevis	A	A	A	A	A	A
16122	Achnanthes laevis var. austriaca	A	A	A	A	A	A
16123	Achnanthes laevis var. diluviana	A	A	A	A	A	A
6259	Achnanthes laevis var. quadratarea	A	A	A	A	A	A
6260	Achnanthes lanceolata ssp. frequentissima	C					
6261	Achnanthes lanceolata ssp. rostrata	C					
6263	Achnanthes lauenburgiana	C	C	C	C		
6266	Achnanthes minuscula	C	C				A
6014	Achnanthes minutissima	A	A	A	A	A	A
6240	Achnanthes minutissima var. gracillima	A	A	A	A	A	A
6267	Achnanthes minutissima var. scotica	A	A	A	A	A	A
6271	Achnanthes petersenii	A	A	A	A	A	A
6984	Achnanthes ploenensis	C	C	C	C	C	C
6272	Achnanthes pusilla	A	A	A	A	A	A
6273	Achnanthes rosenstockii	A	A	A	A	A	A
16662	Achnanthes straubiana	A	A	A	A	A	A
6279	Achnanthes trinodis	A	A	A	A	A	A
6280	Achnanthes ziegleri		A	A	A	A	A

DV-Nr	Taxon	13.1	13.2	10.1	11	10.2	12
6048	Amphipleura pellucida	A	A	A	A	A	A
16582	Amphora hemicycla	C	C	C	C		
6860	Amphora libyca	C	C				
6044	Amphora ovalis	C	C	C	C	C	C
6288	Amphora thumensis	A	A	A	A	A	A
6181	Amphora veneta	C	C	C	C	C	C
6289	Amphora veneta var. capitata	A	A	A	A	A	A
6049	Anomoeoneis sphaerophora	C	C	C	C	C	C
6292	Brachysira calcicola	A	A	A	A	A	A
6293	Brachysira hofmanniae	A	A	A	A	A	A
6294	Brachysira liliana	A	A	A	A	A	A
6295	Brachysira neoexilis	A	A	A	A	A	A
16167	Brachysira procera	A	A	A	A	A	A
6297	Brachysira styriaca	A	A	A	A	A	A
6298	Brachysira vitrea	A	A	A	A	A	A
6299	Brachysira zellensis	A	A	A	A	A	A
6166	Caloneis alpestris	A	A	A	A	A	A
6043	Caloneis amphisbaena	C	C	C	C		
6051	Caloneis bacillum	C					
6301	Caloneis latiuscula	A	A	A	A	A	A
6302	Caloneis obtusa	A	A	A	A	A	A
6304	Caloneis schumanniana	A	A	A	A	A	A
6810	Caloneis tenuis	A	A	A	A	A	A
6058	Cymbella affinis	A	A	A	A	A	A
6310	Cymbella alpina	A	A	A	A	A	A
6311	Cymbella amphicephala	A	A	A	A	A	A
6739	Cymbella amphicephala var. hercynica	A	A	A	A	A	A
6313	Cymbella austriaca	A	A	A	A	A	A
16195	Cymbella austriaca var. erdobenyiana	A	A	A	A	A	A
6314	Cymbella brehmii	A	A	A	A	A	A
6183	Cymbella cesatii	A	A	A	A	A	A
6059	Cymbella cistula					A	A
6979	Cymbella cymbiformis	A	A	A	A	A	A
6315	Cymbella delicatula	A	A	A	A	A	A
6316	Cymbella descripta	A	A	A	A	A	A
6318	Cymbella falaisensis	A	A	A	A	A	A
6319	Cymbella gaeumannii	A	A	A	A	A	A
6184	Cymbella helvetica	A	A	A	A	A	A
6978	Cymbella hustedtii	A	A	A	A	A	A
6324	Cymbella hybrida	A	A	A	A	A	A
16581	Cymbella hybrida var. lanceolata	A	A	A	A	A	A
6325	Cymbella incerta	A	A	A	A	A	A
6326	Cymbella lacustris			A			
6327	Cymbella laevis	A	A	A	A	A	A
6328	Cymbella lapponica	A	A	A	A	A	A
6895	Cymbella microcephala	A	A	A	A	A	A
6977	Cymbella perpusilla	A	A	A	A	A	A
6040	Cymbella prostrata	C					
6333	Cymbella proxima	A	A	A	A	A	A
6334	Cymbella reichardtii	C					
16199	Cymbella schimanskii	A	A	A	A	A	A
6336	Cymbella simonsenii	A	A	A	A	A	A
6150	Cymbella subaequalis	A	A	A	A	A	A
6066	Cymbella tumida	C	C	C	C	C	C
6067	Cymbella tumidula	A	A	A	A	A	A
6339	Cymbella tumidula var. lancettula	A	A	A	A	A	A
6340	Denticula kuetzingii	A	A	A	A	A	A
6068	Denticula tenuis	A	A	A	A	A	A
6807	Diploneis elliptica	A	A	A	A	A	A
6351	Epithemia goeppertiana	A	A	A	A	A	A
6352	Epithemia smithii	A	A	A	A	A	A
6354	Eunotia arcubus	A	A	A	A	A	A
6362	Eunotia glacialis	A	A	A	A	A	A
6851	Eunotia praerupta	A	A	A	A	A	A
6908	Fragilaria capucina var. amphicephala	A	A	A	A	A	A
6389	Fragilaria capucina var. austriaca	A	A	A	A	A	A
6393	Fragilaria capucina var. mesolepta	C					
6394	Fragilaria capucina var. perminuta	C	C				
6186	Fragilaria capucina var. vaucheriae	C	C				
6234	Fragilaria fasciculata	C	C	C	C		
6408	Fragilaria robusta	A	A	A	A	A	A
6819	Gomphonema angustum	A	A	A	A	A	A
6419	Gomphonema auritum	A	A	A	A	A	A
6420	Gomphonema bavaricum	A	A	A	A	A	A
6423	Gomphonema dichotomum	A	A	A	A	A	A

DV-Nr	Taxon	13.1	13.2	10.1	11	10.2	12
6424	Gomphonema hebridense	A	A	A	A	A	A
6425	Gomphonema helveticum	A	A	A	A	A	A
6427	Gomphonema lateripunctatum	A	A	A	A	A	A
6912	Gomphonema minutum	C	C	C	C		
6429	Gomphonema occultum	A	A	A	A	A	A
6867	Gomphonema olivaceum	C	C		C		
6430	Gomphonema olivaceum var. minutissimum	A	A	A	A	A	A
6431	Gomphonema olivaceum var. olivaceoides	A	A	A	A	A	A
6158	Gomphonema parvulum	C	C	C			
6434	Gomphonema procerum	A	A	A	A	A	A
6437	Gomphonema pumilum	C	C	C		C	
6441	Gomphonema tenue	A	A	A	A	A	A
6442	Gomphonema vibrio	A	A	A	A	A	A
16279	Mastogloia baltica	A	A	A	A	A	A
16281	Mastogloia elliptica	A	A	A	A	A	A
6804	Mastogloia grevillei	A	A	A	A	A	A
6445	Mastogloia smithii var. lacustris	A	A	A	A	A	A
6448	Navicula absoluta	A	A	A	A	A	A
6018	Navicula accomoda	C	C	C	C	C	C
6117	Navicula atomus	C	C	C	C	C	C
6241	Navicula atomus var. permitis	C	C	C	C	C	C
6087	Navicula bacillum	C	C	C			A
6461	Navicula bryophila	A	A	A	A	A	A
6868	Navicula capitata	C	C	C			
6966	Navicula capitata var. hungarica	C	C	C	C	C	
6463	Navicula capitata var. lueneburgensis	C	C	C			
6910	Navicula capitatoradiata	C	C				
6088	Navicula cari	C	C				
6464	Navicula catalanogermanica				A	A	A
6465	Navicula clementioides	C	C	C	C	C	
6466	Navicula clementis	C	C	C	C	C	C
6969	Navicula cocconeiformis	A	A	A	A	A	A
6468	Navicula concentrica	A	A	A	A	A	A
6470	Navicula costulata	C	C	C	C		
6010	Navicula cryptocephala	C	C	C	C	C	C
6038	Navicula cuspidata	C	C	C	C		
6472	Navicula dealpina	A	A	A	A	A	A
16308	Navicula declivis						
6473	Navicula decussis	C	C	C			A
6474	Navicula densilineolata	A	A	A	A	A	A
6478	Navicula diluviana	A	A	A	A	A	A
6826	Navicula elginensis	C	C	C	C	C	A
6967	Navicula gastrum						A
6490	Navicula gastrum var. signata						A
6916	Navicula goeppertiana	C	C	C	C	C	C
6493	Navicula gotlandica	A	A	A	A	A	A
6015	Navicula gregaria	C	C	C	C	C	C
6833	Navicula halophila	C	C	C	C	C	C
6505	Navicula jaagii	A	A	A	A	A	A
6506	Navicula jaernefeltii	A	A	A	A	A	A
6882	Navicula laevissima	A	A	A	A	A	A
6864	Navicula lanceolata	C	C	C	C	C	C
6094	Navicula menisculus	C	C	C	C	C	C
6514	Navicula menisculus var. grunowii	C	C	C			
6516	Navicula minusculoides	C	C	C	C	C	C
6219	Navicula molestiformis	C	C	C	C	C	C
6861	Navicula monoculata	C	C	C	C	C	C
6521	Navicula oligotraphenta	A	A	A	A	A	A
6522	Navicula oppugnata	C	C	C	C		
6099	Navicula placentula	C	C	C	C		A
6524	Navicula praeterita	A	A	A	A	A	A
6100	Navicula protracta	C	C	C			
6525	Navicula pseudanglica	C	C	C			A
6529	Navicula pseudoscutiformis	A	A	A	A	A	A
6530	Navicula pseudotuscula	C					A
6531	Navicula pseudoventralis	A	A	A	A	A	A
6534	Navicula recens	C	C	C	C	C	C
6221	Navicula reichardtiana	C					
6104	Navicula reinhardtii	C	C	C	C	C	C
16362	Navicula rhynchotella	C	C	C	C	C	C
6537	Navicula saprophila	C	C	C	C	C	C
6926	Navicula schoenfeldii	C	C				
6541	Navicula scutelloides	C				A	A
6192	Navicula seminulum	C	C	C	C	C	C
6873	Navicula slesvicensis	C	C	C	C	C	C

DV-Nr	Taxon	13.1	13.2	10.1	11	10.2	12
6546	Navicula stroemii	A	A	A	A	A	A
6547	Navicula subalpina	A	A	A	A	A	A
6896	Navicula subminuscula	C	C	C	C	C	C
6831	Navicula tripunctata	C	C				
6870	Navicula trivialis	C	C	C	C	C	C
6989	Navicula tuscula	A	A	A	A	A	A
6555	Navicula tuscula f. minor	A	A	A	A	A	A
6556	Navicula utermoehlii	C					
6890	Navicula veneta	C	C	C	C	C	C
6832	Navicula viridula var. linearis	A	A	A	A	A	A
6559	Navicula vitabunda	A	A	A	A	A	A
6560	Navicula vulpina	A	A	A	A	A	A
6561	Navicula wildii	A	A	A	A	A	A
16589	Naviculadicta schaumburgii	C	C	C	A	A	A
6820	Neidium affine	A	A	A	A	A	A
6564	Neidium ampliatum	A	A	A	A	A	A
6575	Nitzschia alpina	A	A	A	A	A	A
6039	Nitzschia amphibia	C	C				
6991	Nitzschia angustata				A	A	A
6577	Nitzschia bacilliformis	A	A	A	A	A	A
16048	Nitzschia calida	C	C	C	C	C	C
6964	Nitzschia capitellata	C	C	C	C	C	C
6194	Nitzschia communis	C	C	C	C	C	C
6242	Nitzschia constricta	C	C	C	C	C	C
6584	Nitzschia dealpina	A	A	A	A	A	A
6008	Nitzschia dissipata	C		C			
6587	Nitzschia diversa	A	A	A	A	A	A
6589	Nitzschia fibulafissa	A	A	A	A	A	A
6195	Nitzschia filiformis	C	C	C	C	C	C
6025	Nitzschia fonticola	C	C				
6222	Nitzschia fossilis	C	C	C	C	C	C
6196	Nitzschia frustulum	C	C	C	C	C	C
6592	Nitzschia gessneri	A	A	A	A	A	A
6593	Nitzschia gisela	A	A	A	A	A	A
6114	Nitzschia hungarica	C	C	C	C	C	C
6595	Nitzschia inconspicua	C	C	C	C	C	C
6597	Nitzschia lacuum					A	A
6888	Nitzschia levidensis	C	C	C	C	C	C
16102	Nitzschia levidensis var. salinarum	C	C	C	C	C	C
16423	Nitzschia liebetruthii	C	C	C	C	C	C
6024	Nitzschia linearis	C	C	C	C		
6599	Nitzschia linearis var. subtilis	C	C	C	C	C	C
6600	Nitzschia linearis var. tenuis	C	C	C	C	C	C
6198	Nitzschia microcephala	C	C	C	C	C	
6607	Nitzschia radicula	A	A	A	A	A	A
6608	Nitzschia regula	A	A	A	A	A	A
6961	Nitzschia sociabilis	C	C	C	C	C	
6960	Nitzschia sublinearis	A	A	A	A	A	A
6924	Nitzschia supralitorea	C	C	C	C	C	C
6118	Nitzschia umbonata	C	C	C	C	C	C
6125	Pinnularia microstauron	A	A	A	A	A	A
6667	Pinnularia subgibba	A	A	A	A	A	A
6224	Rhoicosphenia abbreviata	C	C				
6677	Rhopalodia gibba	A	A	A	A	A	A
6678	Rhopalodia gibba var. parallela	A	A	A	A	A	A
16498	Stauroneis anceps var. siberica	A	A	A	A	A	A
6693	Surirella brebissonii	C	C	C	C	C	C

Case: EE
Status: national input for intercalibration, assessment and legalisation under development

Which indicators are used?

Macrophyte composition:

The taxonomic composition of hydrophytes is assessed for angiosperms, mosses and charophytes in most cases on species level (sometimes lacking for mosses and charophytes). Large filamentous green algae are included on genus or higher level. Also emergent macrophytes and hygrophytes (hydrophilous plants growing outside from water edge or in temporarily flooded zone) are included. The amount and composition of emergent plants and hygrophytes may be indicative *e.g.* for LCB3 lakes.
Growth forms for hydrophytes are understood as not very strictly indicative. Following characterization of different groups forms the basis for our classification:
Bottom plants – isoetids (*Isoëtes, Lobelia*), mosses (*Fontinalis*, *Drepanocladus, Warnstorfia etc*.), charophytes (*Chara*, *Nitella, Nitellopsis etc*.) are the most sensitive, as they need favourable light and bottom conditions (oxygen, mineral sediment). Also many of small-sized amphibious species need open littoral (without tall emergent plants) and mineral sediments, characteristic of lakes of lower trophy levels. However, charophytes may be very abundant in nitrogen-rich but phosphorus-poor alkaline water bodies. In the most alkaline water bodies phosphorus may be bound into complex with carbonate compounds and is not available for producers. So in alkalitrophic charophyte-lakes enrichment with P may be hidden, and N-loading serious.
Elodeids = plants rooting in bottom, growing up to water surface and flowering there – waterweeds (*Elodea*), pondweeds (*Potamogeton*), milfoils (*Myriophyllum*), crowfoots (*Ranunculus* = *Batrachium*) are related to high, good or moderate status. Generally (not all!) species with fine-divided leaves tolerate better turbid water, and some relatively weakly rooted turion-producing species as *Potamogeton friesii* are more tolerant to organic-rich sediments. The shoots of *P. friesii* may be decayed already in July, and the plant survives by turions. The indicators of high or good quality in this group are broad-leaved pondweeds such as *Potamogeton perfoliatus, P. lucens, P. praelongus, P. alpinus* and *P.gramineus*.
Ceratophyllids or weakly rooted plants – hornworts (*Ceratophyllum*), water soldier (*Stratiotes*), bladderworts (*Utricularia*) – are quite different regarding the indicativity. *Ceratophyllum* seems to be more indicative for shallow hard-water lakes of moderate or poor status, where it usually reflects accumulation of organic matter and oxygen-deficiency in bottom layer. In larger and deeper hard-water lakes (remembering also our excursion in Northern Germany!) the correlation with lake quality is not clear. *Stratiotes* is also usually connected with areas of more organic-rich sediments, but it is sensitive to anaerobic conditions. Among bladderworts, *Utricularia vulgaris* may grow in the lakes from high to moderate status; the other species seem to be more sensitive.
Lemnids or floating plants – duckweeds (*Lemna, Spirodela etc.*), frogbit (*Hydrocharis*), some liverworts (*Riccia, Ricciocarpus*) can grow in these lakes or their parts where nutrients are available from water, and in boreal region they are mostly characteristic of increased trophy level. However, indicativity of the species is very probably different. Most of them seem to prefer sheltered places rich in dissolved organic matter. *Spirodela polyrhiza* is a characteristic species of wastewater inflows in hard-water lakes. Some species, as *Lemna minor*, are found also on the surface of the brown-water lakes where pH is low (to 5.5). In such lakes abundant duckweeds and floating-leaved plants may be the single indicator of nutrient loading, as submerged plants are naturally absent.
Nymphaeids or floating-leaved plants – water lilies (*Nuphar, Nymphaea etc*.), amphibious bistort (*Persicaria amphibia* = *Polygonum amphibium*), bur-reed

(*Sparganium*) and broad-leaved pondweed (*Potamogeton natans*) are very different regarding indicativity. This group includes more or less "cosmopolitic" species, as *Nuphar lutea*, as well as extremely sensitive strictly adapted species, as *Sparganium angustifolium*. The first can grow at very different alkalinity and water colour, and also in lakes where all submerged plants are extinct. Increase in "common" nymphaeid species, in our opinion, reflects the eutrophication and the accumulation of organic sediment.

Macrophyte abundance:

The estimations of **relative** abundance are given according 5 abundance classes (Table 1) originally used by Braun-Blanquet (1951) for geobotanical quadrates. For the lakes we have given the estimations for the whole water body. Besides, the description of abundance classes differs slightly from that by Braun-Blanquet.

Table 1. The species abundance scale.

1	rare, single plants or small stands
2	in some places, several small or two-three medium-sized stands
3	frequently, may be among subdominants or co-dominants
4	in large amounts, dominant or co-dominant
5	in masses, absolute dominant (quite rare situation!)

The estimations of relative abundance are given separately among three groups:

a) emergent plants (helophytes) and hygrophilous plants;
b) floating and floating-leaved plants (lemnids and nymphaeids),
c) submerged plants (bottom plants, elodeids, ceratophyllids);

For large filamentous algae – not relative abundance, but related to volume or coverage (5= covering all submerged plants or forming wide floating carpets)

The major weakness is subjectivity of estimation. Depending on researcher, the points may differ ±1. In macrophyte-rich lakes higher abundance classes for the dominating species may be given more easily than for the dominants in the lakes poor of macrophytes.

Depth limit of macrophytes

Depth limit has been measured for all rooted plant groups growing in the lake. Usually, submerged plants are the most deep-reaching group, but in some lakes nymphaeids may grow deeper. In *Lobelia*-lakes without *Isoëtes* and mosses, also emergent plants (reed) may exceed isoetids. Despite these circumstances, for the estimation of quality classes only depth limit of submerged groups has been used. Depth limit of submerged plants is more indicative for deeper hard-water (LCB1) lakes than for very shallow hard-water (LCB2) lakes. In LCB3 lakes the indicativity of depth limit depends on presence of mosses, growing mostly in deeper soft-water lakes. Isoetids in EE lakes are restricted with 2-2.5 m depth limit. In some cases, at slightly increased alkalinity (disturbance?) also charophytes, especially *Chara delicatula* and *Nitella flexilis* can grow in deeper zone.

Macrophyte coverage

It is not used for quality estimations in the latest version of our method, but coverage, and in some cases also PVI, have been calculated or estimated in different ways. At the availability of bathymetric maps and vegetation scheme, and knowing the common depth limit of macrophytes, it is possible to extirpate vegetated areas from the lake scheme and to compare their weight with weighted pelagial part. In small lakes without bathymetric map the calculations are based on length of shoreline, vegetation scheme and estimated/measured widths of plant stands. For calculating PVI, the height of plants must be measured too for more exact calculating. Also very general subjective coverage estimations, and rake method for the estimation of PVI classes have been used for some projects. Despite the absence of coverage % among indicators at present, it may be useful in more differentiated way, and probably will be again included in future. Our analysis on the coverage % for all submerged groups as total, revealed low indicative value of this parameter (Mäemets & Freiberg, submitted).

Diatoms and bacterial tufts
<u>These groups are not monitored in lakes, but diatoms are monitored in rivers.</u>

Summary of used criteria: Tables 3-5, Annex 1.

Sampling strategy

Frequency for macrophyte investigations is not prescribed yet. It has been depending on labour and changing monitoring strategy.

Monitoring procedure

Usually, small lakes are circled by boat, partly in deeper zone and along transects, partly in shallower zone near the water edge (Figure 1). Composition of submerged plants and depth limits have been studied using plant hook (in very shallow water also rake) with marked rope (stock). Diving has been used rarely. Turbid or dark water and loose mud in deeper zone hinder the diving in many cases. In shallow water (until 1 m) species composition and coverage mostly have been described without equipment, and in the clearest lakes with observation tube in 1-2 m zone. On the largest lakes of Peipsi (3555 km^2) and Võrtsjärv (270 km^2) monitoring is carried out on transects.

Numbers of transects per lake

The number of transects has not been prescribed/calculated until now, and has been depending on the experience of the investigator. In lakes with more articulate or geologically variable shore (sandy, peaty, limestone *etc*.) more transects have been studied than in the case of monotonous or obviously macrophyte-poor shore stretches. Transects starts from the water border and reaches to deepest part of littoral (maximum growth depth).

Analyses
Determination
Most plants are determined to species in the field, and partly validated in the laboratory. Charophytes and mosses are determined to genus or higher taxa in the field and collected for species determination.

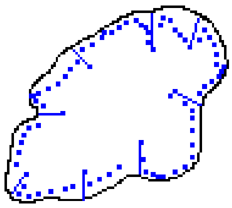


Figure 1. Scheme of a monitoring route

Way of reporting basic data

Ministery of Environment will become full species lists for monitored lakes (with depth limits and abundances): for the investigation year and (comparatively) for earlier investigation times. Separately are presented estimation tables with summarized quality decisions (an example presented in Annex). Also short descriptive characterizations of changes and present state are included into monitoring reports. In Centre for Limnology the data will be included into general database. Statistical analyses have been made on the basis of this database. Automatical calculation of metrics or indexes has not set on.

Assessment

Data requirements

Table 2. Shortened (deleted are columns of code, region, coverage percentages for different growth forms *etc*.) example of the first part of EE database for small lakes. The findings without estimated abundance (mostly hygrophytes) are marked with –999; in example not presented.

Lake	Area, ha	Type	Time	Not full study	occu-pied %	depth limit of emerg.	depth limit of floating-leaved pl.	depth limit of sub-merg.	Acor cala	Agro stol
Aavoja vh	26,0	DE4	19.06.1990							
Aegviidu Ahvenajv.	0,85	O3	21.06.2002	Natura	10					1
Aegviidu Sisalikujv.	0,5	O3	21.06.2002	Natura	25					1
Aegviidu Vahejv.	3,1	E1	23.07.1968							
Aegviidu Vahejv.	3,1	E1	25.07.1981		ult* 90					
Aela	9,8	DE2	10.08.1977							
Agali		E6	30.07.1973					4,0		
Agali		E6	27.06.1989				2,7	3,5		
Aheru	234,0	E5-DE	1952, 55					1,8		
Aheru	234,0	E5-DE	1975							
Aheru	234,0	E5-DE	1989				2,2	3,3		

* ult = floating-leaved plants

The following tables (3-5) present quality parameters and their values for different EE lake types, as they were before the Edinburgh meeting (5.-7.02.07). In cooperation with Dutch colleagues they were modified and used for the calculation of EQR-s in the GIG database. In Table 3 are included alkalitrophic lakes, special for EE, and in Table 5 are presented criteria for coastal lagoons (brackish and freshwater). Most unclear are the criteria for bad status, as happily we have not many examples of such lakes. So the values of the parameters for the class V are mostly absent. All values, excluding depth limits, are based on expert opinion.

Table 3. The criteria for quality estimations of alkalitrophic, LCB1 and LCB2 lakes

Parameters/Classes	High	Good	Moderate	Poor	Bad
Only for LCB1: Depth limit of submergent plants, m	<4	<3.0-4.0	>1.6-3.0	1-1.6	<1
More important taxa* arranged according their role	Char, Pot, Bry	Char, Pot, Bry	Batr, Cer, Pot, Nym	Cer, Nym, Nu, Lem	-
Relative abundance of *Potamogeton perfoliatus* and /or *P. lucens*	2-4	2-4	1	0-1	-
Abundance of charophytes and/or bryophytes	≥3	2-3	1	0	0
Abundance of ceratophyllids and/or lemnids	1	1-2	3	4-5	-
Abundance of large filamentous algae	0	1	2	3-4	5

*Char – charophytes; Bry – Bryophytes; Pot – *Potamogeton*; Batr – *Batrachium*; Cer – *Ceratophyllum*; Nym – *Nymphaea*; Nu – *Nuphar*; Lem – lemnids (*Lemna, Spirodela* Table 2.

Table 4. The criteria for quality estimations of LCB3 lakes.

Parameters/Classes	High	Good	Moderate	Poor	Bad
Depth limit of mosses, m (only in lakes with mean depth > 3 m)	>7	>4-7	2-4	<2	-
More important taxa* arranged according their role	Iso, Bry	Iso, Bry, Char	El, Pot, Char	-	-
Abundance of isoetids	4	3-4	2	1	absent
Abundance of elodeids**	0	1	2	3	-

*Iso – isoetids: *Isoëtes, Lobelia*; Bry – Bryophyta; El – *Elodea*; Pot – *Potamogeton*; Char – Charophyta

** *Elodea, Potamogeton, Batrachium, Myriophyllum*

Table 5. The criteria for quality estimation of coastal lakes (lagoons).

Parameters/Classes	High	Good	Moderate	Poor	Bad
Relative abundance of *Chara aspera*	4-5	3	1-2	0	-
Relative abundance of *Chara tomentosa*	4-5	2-3	1	0	-
Relative abundance of *Cladium mariscus*	4-5	3	1-2	0	-

In order to report an EQR value the different classes are assigned with the following values: Bad 0.00; Poor 0.30; Moderate 0.50; Good 0.7; High 1, where 0.2, 0.4, 0.6, 0.8 are the boundaries vor B/P; P/M; M/G; and G/H respectively. The median value of all parameters represents the final assessment of the quality element macrophytes.

How are reference conditions, H/G and G/M boundaries derived?

Reference lakes are not presented (regarding macrophytes), as almost all studied EE lakes have been under the human impact earlier or later. Diatom analyses from the sediments of some "reference" lakes with recently weakly inhabited and not polluted catchment areas have revealed earlier events, changing the following development. Conception of high status is based on the data from the 1950s, in some cases also on the older data. Following (in database) the changes in the second half of the 20th century, understanding of the indicators of declining quality has been formed. H/G boundary is the state where the first signs of vegetation change appear, and G/M boundary is the state where the representatives of H and G state are present, but not prevailing. The vegetation of the lakes on G/M boundary seems to be unstable.

How well correlate the indicators with pressure indicators?

Correlations of coverage % and depth limit are analysed. The last parameter seems to be useful for quality classification, *e.g.* correlation between depth limit of submerged plants with Chl α content in midsummer samples from surface layer (Figure 2) was –0.3276 (p=0.017). Coverage % of submerged macrophytes may be high in the lakes of good state, *e.g.* charophyte-rich coastal lagoons on nature protection areas, but charophyte-rich are also the lakes with lowered water level and heavily fertilized catchment area, *e.g.* overgrowing lakes on Vooremaa drumlin area, where impact of agriculture has been strong during long time.

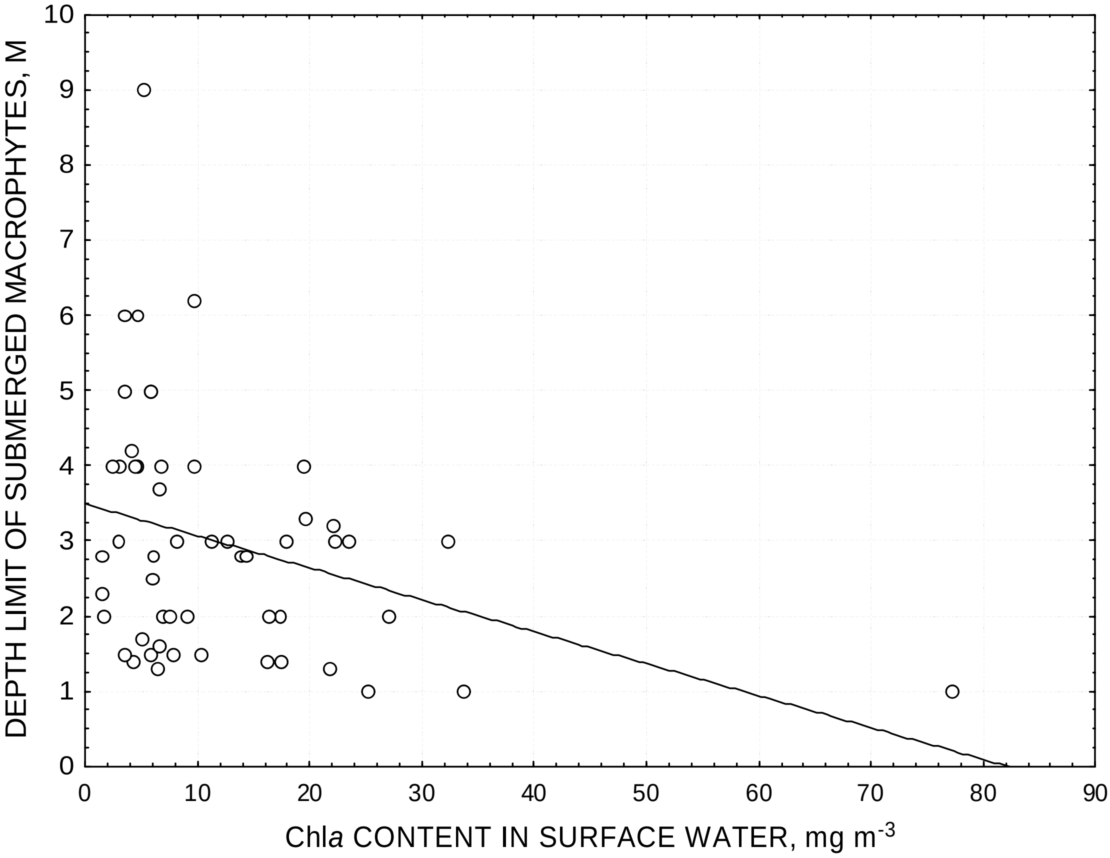


Figure 2. Chlα content in midsummer samples and depth limit of submerged macrophytes in EE lakes of different types according 55 parallel measurements (Mäemets & Freiberg, submitted).

Annex 1. Example of quality estimation for Lake Verevi (LCB1) according the EE criteria.

Parameter/Year	**2002**	**2003**	**2005**	**2006**	**Comments**
Depth limit of submergent plants, m	4.0: II	4.0: II	3.0: III	4.0: II	
More important taxa* arranged according their role	Pot, Char: I-II	Cer, Myr: III	Bry: I	Bry, Cer, Myr, Batr, Char: II	Only *Myriophyllum verticillatum*
Relatve abundance of *Potamogeton perfoliatus* and /or *P. lucens*	2: I-II	1: III	1: III	0: IV-V	
Abundance of charophytes and/or bryophytes	3: II	2: II	5: I	4: I	
Abundance of ceratophyllids and/or lemnids	3: III	4: IV	2: II	3: III	
Abundance of large filamentous algae	1: II	4: IV	2: III	4: IV	
General estimation	**II**	**III**	**II**	**III**	

Case: PL

Status: the original method (so called MFI – MacroPhytoIndication) was developed in early 80'es (Rejewski 1981); during the project running 2005 and 2006 detailed sampling strategy was developed and assessment method was adopted to meet the WFD requirements; method was officially accepted by Ministry of Environment in November 2006 and has to be implemented in monitoring program from 2007 (probably need to be upgraded after two years of using in routine monitoring - pilot study).

Which indicators are used?

Macrophyte syntaxonomic composition:

The Polish method is based on syntaxonomic composition (according to the phytosociological method by Braun-Blanquet 1964) which means that only plant communities are recorded. Plant community is the species association of the minimum area >1m^2 and the cover >25 % (please, note that single plant is not a community and is not recorded). All plant communities occupying phytolitoral area are identified, submerged and emergent as well, including hydrophytes (charophytes, mosses and potamids), floating-leaves (nympheaids), non rooting limneids and emergent helophytes (rush and sedge rush).

Macrophyte abundance:

Sampling strategy is based on the belt-transect method. The abundance represents the %cover of each plant community on each belt transect in 7 point scale (see table 1).

Table 1. Polish plant communities abundance scale

Estimated % cover of each plant community on the belt transect	Scale (acc. to Braun-Blanquet scale)
75 – 100	**5**
50 – 75	**4**
25-50	**3**
5-25	**2**
1-5	**1**
0,1 –1	**+**
<0,1	**r**

Composition and abundance of phytobenthos:
Phytobenthos is not used in the assessment acc. to this method (separate method of assessment based on phytobenthos will be developed).

Bacterial tufts:
Bacterial tufts are not used in the assessment.

Summary

In order to calculate all metrics used in Polish method following data is needed:

- number of plant communities recorded in phytolittoral (including all plant groups listed above);
- total area of phytolittoral (calculated from max. depth of plant growth, based on bathymetric plan)
- %share of each plant community in total phytolittoral area.

How are these indicators monitored?

Sampling strategy

Before the WFD has become into force, macrophytes were not examined in routine monitoring in Poland.
In early ‘80ies the MacroPhytoIndication method (so called MFI) was developed by Rejewski (1981) and used for scientific purposes only. In this method the vegetation was examined around the whole phytolittoral using rake or grapnel and the whole littoral was mapped.
During the last years MFI method was modified several times by Ciecierska (2003, 2004, 2005).
In 2005-2006 the “macrophyte project” supported by Polish Ministry of Environment was running. The aim of the project was to adopt the MFI method to meet WFD requirements and to develop a new, fully WFD compliant, monitoring method.

In order to adopt the sampling method to the capacities of the regional services (when mapping is a very time- and work-consuming method) also a new sampling strategy was developed based on belt transects.

Numbers of samples per lake

For each lake a minimum number of belt transects required is calculated according to Jensen formula (Jensen 1977, Keskitalo & Salonen 1994). Number of transects depends on the area and the shape of the lake; normally it makes one transect for app. 500m length of shoreline. The width of the transect is about 20-30 m in order to enable boat manoeuvering and the length is from the shoreline to the max. depth of plant growth.
Each transect is sampled with a rake in order to identify all plant communities, share of each plant community in 7 point scale, % of total plant cover within a transect and maximum depth of plant growth.

When is monitored and with which frequency?

The field study is conducted in the middle of the vegetation season, normally mid of June – mid of September; ones for each lake designated to monitoring network in each 6 years plan.

Use of equipment

For sampling plants in most cases a rake is used connected to a scaled rope. Sampling bags or jars with alcohol are used for fixation for “problematic” species determination in lab (mosses, charophytes).

Analysis of sample and level of determination

Polish method is based on syntaxonomic level and not single plants but plant communities are identified. For this reason plants are determined to species level in the field. Some taxa (e.g. Charophytes and mosses) are validated in the laboratory.

Way of reporting basic data

Data from all transect is then averaged in order to determine indicators used in metric calculation: the number and list of plant communities, average depth of plant growth, total phytollitoral area and the % share of each community. They are then the basis to calculate all metrics of ESMI method.
In order to store the data and to calculate all metrics of ESMI method the special simple software was designed on national level.

Assessment

Data requirements

To calculate all metrics of Polish method following data is required:

- total lake area (P);
- total area of phytolittoral (N);
- number of plant communities identified in phytolittoral (S);
- % share of particular plant communities (n_i);
- area of the minimum potential phytolitoral determine by the isobath 2,5 m (area from the shoreline, limited by the isob. 2,5)

Methods of calculation

Using all data listed above it is possible to calculate three metrics of Polish method:

- Phytocenotic diversity index (H) from the Shannon – Weaver formula:

$$H = -\sum \frac{n_i}{N} \times \ln \frac{n_i}{N}$$

- Maximum phytocenotic diversity index (H_{max}):

$$H_{\max} = \ln S$$

- Colonization index (Z):

$$Z = \frac{N}{izob.2{,}5}$$

These three are then combined in one multimetric - Ecological State Macrophyte Index (ESMI):

$$ESMI = 1 - \exp\left[-\frac{H}{H_{\max}} \times Z \times \exp\left(\frac{N}{P} \right) \right]$$

Exponential function in formula is used in order to get ESMI values in the range from 0 to 1.

Then the ESMI value is classified into 5 classes of ecological state but class boundaries are different for different macrophyte lake types:

Ecological state	ESMI value:	
	Stratified lakes	**Non-stratified lakes**
High	0,680 – 1,000	0,680 – 1,000
Good	0,340 – 0,679	0,270 – 0,679
Moderate	0,170 – 0,339	0,110 – 0,269
Poor	0,090 – 0,169	0,050 – 0,109
Bad	<0,090	<0,050
	No submerged plants	

How are reference conditions, H/G and G/M boundaries derived?

The new method was elaborated on the basis of the scientific dataset comprises more than 150 lakes (lake-years) surveyed with MFI method (detailed mapping of the whole phytolittoral) in the last 30 years. In the dataset mostly reference lakes and lakes in high and good status were collected (due to scientific projects aimed on exploring natural ecosystems). For all lakes in dataset ESMI values were calculated.
Reference value was determined as a median value of ESMI from real reference lakes identified according to the pressure criteria, for stratified and non-stratified lakes separately
(spatial method).
H/G boundaries were determined as 75th percentil from the distribution of reference lakes (it gave 0,676 for stratified lakes and 0,679 for mixed ones - in the classification both values rounded to nearest 0,010 –> 0,680). The whole range of ESMI from the boundary H/G to the minimum value identified in database (for stratified and non-stratified lakes separately) was then divided in four classes in logarithmic scale.

How well correlate the indicators with pressure indicators?

During our "macrophyte project" we tested the relationship between particular metrics and ESMIndex itself in the pressure gradient (expressed as TP, chl a, SD and cumulative indicator - water quality class acc. to Polish monitoring method: Lake Quality Evaluation System (Kudelska, Soszka & Cydzik 1994)).
For the results see tables and figures below (tab. 1-3, fig. 1-3).

Tab. 1. Relationship between phytocenotic diversity index (H) and pressure indicators (chl *a* [ug/l], Secchi disc reading [m], TP [mgP/l] and water quality classes according to Polish Lake Quality Evaluation System [LQES]) in stratified and mixed lakes

Pressure indicators	**Stratified hard-water lakes**			**Non-stratified hard-water lakes**		
	r^2	r	p	r^2	r	p
log chl *a* (mean)	0,043	-0,206	0,234076	**0,095**	-0,309	0,015445
log SD (mean)	**0,129**	0,360	0,033747	**0,176**	0,420	0,000756
log TP (mean)	0,034	-0,184	0,288701	**0,136**	-0,369	0,003389
log LQES classes	**0,113**	-0,336	0,048280	**0,158**	-0,398	0,001509

Tab. 2. Relationship between colonisation index (Z) and pressure indicators (chl *a* [ug/l], Secchi disc reading [m], TP [mgP/l] and water quality classes according to Polish Lake Quality Evaluation System [LQES]) in stratified and mixed lakes

Pressure indicators	**Stratified hard-water lakes**			**Non-stratified hard-water lakes**		
	r^2	r	p	r^2	r	p
log chl *a* (mean)	**0,576**	-0,759	0	**0,313**	-0,559	0,000003
log SD (mean)	**0,482**	0,694	0,000004	**0,389**	0,624	0
log TP (mean)	**0,290**	-0,538	0,000853	**0,303**	-0,550	0,000004
log LQES classes	**0,472**	-0,687	0,000005	**0,444**	-0,666	0

Tab. 3. Relationship between Ecological State Macrophyte Index (ESMI) and pressure indicators (chl *a* [ug/l], Secchi disc reading [m], TP [mgP/l] and water quality classes according to Polish Lake Quality Evaluation System [LQES]) in stratified and mixed lakes

Pressure indicators	**Stratified hard-water lakes**			**Non-stratified hard-water lakes**		
	r^2	r	p	r^2	r	p
log chl *a* (mean)	**0,662**	-0,814	0	**0,360**	-0,600	0
log SD (mean)	**0,552**	0,743	0	**0,464**	0,681	0

log TP (mean)	**0,315**	-0,561	0,000455	**0,351**	-0,592	0
log LQES classes	**0,512**	-0,715	0,000001	**0,457**	-0,676	0

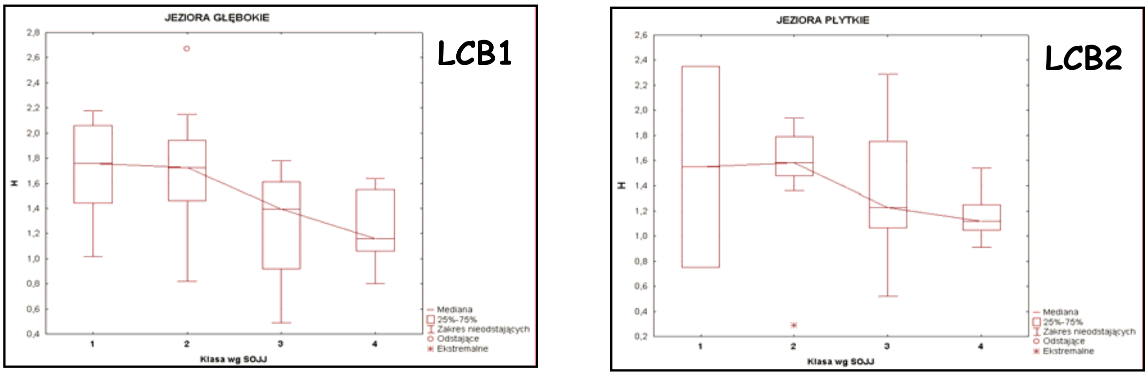


Fig. 1. Relationship between phytocenotic diversity index (H) and water quality classes acc. to Polish LQES in stratified and polymictic lakes

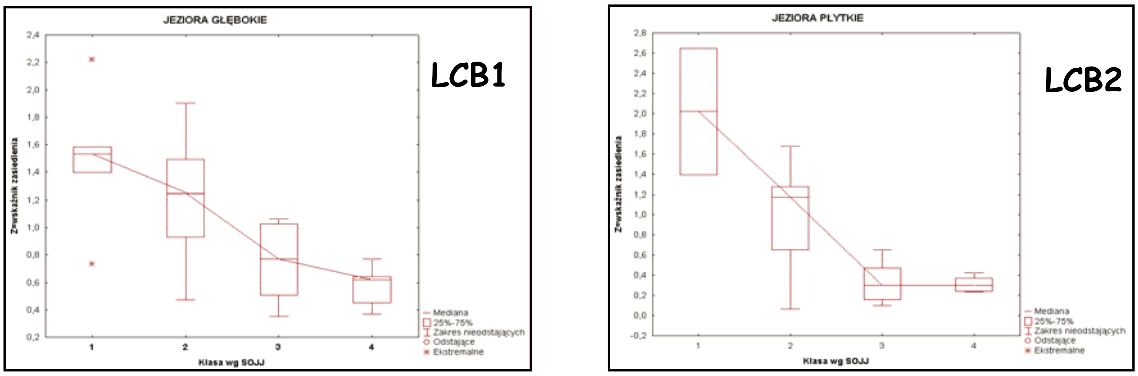


Fig. 2. Relationship between colonisation index (Z) and water quality classes acc. to Polish LQES in stratified and polymictic lakes

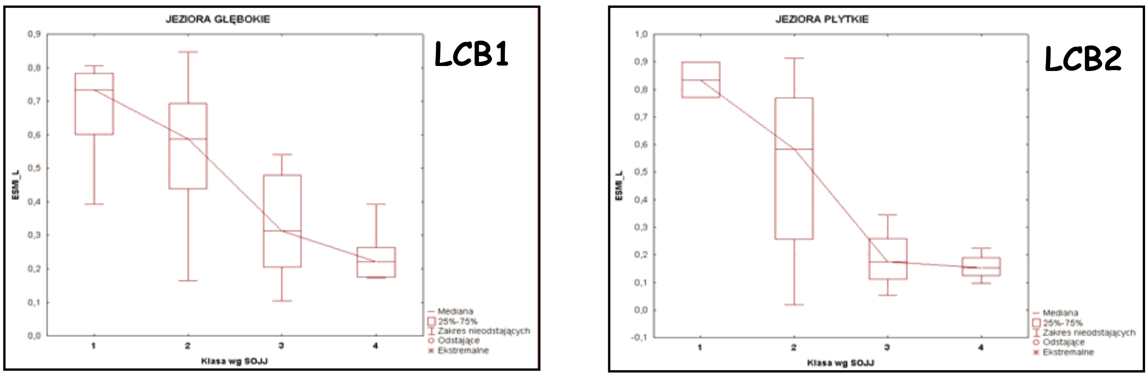


Fig. 3. Relationship between Ecological State Macrophyte Index (ESMI) and water quality classes acc. to Polish LQES in stratified and polymictic lakes

Case: NL

Status: national input for intercalibration, assessments are under development, no legal status

Which indicators are used?

Macrophyte taxonomic composition:
The taxanomic composition of hydrophytes is assessed on species level. Hydrophytes includes angiosperms, charophytes and submerged and floating mosses. Other macroalgea (e.g. *Hydrodictyon* sp.) are not included. Besides an assessment of the species composition, growth forms are assessed separately. Six growth forms are used: submerged, nymphaeids, emergent, floating algae beds, free floating (*Lemnids*), and amphibious. Not all growth forms are considered as indicator for each lake type, and combinations of growth forms are made for some lake types.

Macrophyte abundance:
The metric for species composition uses 3 classes of abundance (and 0 if absent), see table 1. The abundance represents the occurrence of the species for the whole lake. The basic abundance data are however in a more precise scale (% cover or other abundance scales, and multiple sample locations).

Table 1. The Dutch species abundance scale.

1	Zeldzaam of schaars voorkomen	rarely/scarcely occurrence
2	Frequent en/of plaatselijk voorkomen	locally/frequently occurrence
3	Algemeen of (co)dominant voorkomen	common/dominant

The growth forms are expressed as percentage cover of the lake. Not always the whole lake area is considered. For most growth forms a lake specific maximum potential area is defined. For submerged macrophytes this is defined by a depth limit (LCB1: 4,5 m; LCB2: 2,7m). For amphibious plants the potential area is defined by the area which is naturally falling dry during summer. The actual area of each growth form is expressed as percentage of the maximum potential area. The area potentially covered with amphibious plants is estimated by taking the difference between averaged highest water level in winter and averaged lowest water level in summer. In combination with the morphology of the lake, the area falling dry can be calculated. The area falling dry is assumed as the potential area to be covered with amphibious plants. For emergent macrophytes and nympaeids the potential area is defined by depth and wind fetch. A statistical model predicts the area, but each area is maximally 10m ahead from the nearest point falling dry. Both growth forms emergent macrophytes and nympaeids are only considerd relevant in smaller lake types however.

Composition and abundance of phytobenthos:
Due to uncertainty about validation and lacking of intercalibration results (for lake types) the metric for phytobenthos is not yet included in the assessment.

Bacterial tufts:
Bacterial tufts are not used in the assessment of the quality element, because lack of data and information for suitable indicators and its reference values.

Summary
<u>species composition</u>: score of characteristic taxa
<u>growth form</u>: % cover of growth form (submerged, nymphaeids, emergent, floating algae beds, lemnids, and amphibious) per potential covered area.
Both indicators have the same weight to calculate the final flora assessment.

How are these indicators monitored?

Sampling strategy

species composition and growth form
Before the WFD has become into force, a number of methods have been used for monitoring macrophytes. Random sampling, transect sampling, and in some cases 'practical sampling' has been used in the past. For the data present in the GIG data base monitoring is carried out by transect sampling, and random sampling, and 'complete' sampling (i.e. very dense sampling network). Also different methods of sampling are used (double rake with rope, snorkeling, naked eye). Although different methods are used, the Dutch experts are rather sure that the way of monitoring is good enough for the requirements of the GIG data base.
A statistical analysis of a large data based had shown that the monitoring program could much more effective by taking into account sources of variance in the composition. The depth zone (split: <1.5; 1.5-3; >3) appeared to be the most important source of variance. Therefore, in future (2007 onwards) a stratified random sampling technique will be used. Different depth classes are sampled and within each depth class sites are randomly selected once and will be 'permanent' afterwards. The monitoring results will be corrected for the occurrence of different depth zones in the lake.

phytobenthos
Before the WFD, phytobenthos is almost only studied in poorly buffered lakes, and not in alkaline lakes. Samples are taken from hard and natural substrates (e.g. reed or stones). If no natural hard substrate is available, artificial substrate (e.g. reed) should be used. Site selection is not prescribed but should not be purely in the littoral.

Numbers of samples per lake

species composition and growth form
Each lakes consist of 6, 10 or 20 sampling points per depth stratum (resp. for lakes <100 ha, <500&>100, >500ha). Each sampling point has a size of 200x200m and is sampled at each corner 5 times with a rake.

phytobenthos
One sample location is sufficient as long as 10-30 reed stems (or other hard substrates) can be collected from a representative site in or close to the open water.

When is monitored and with which frequency?

species composition and growth form
Samples are taken once in the middle of growing season i.e. 15th June-15th August. Inter annual cycle depends on monitoring type.

phytobenthos
Between 1st April and 1st June. In case of artificial substrate at least 4 weeks incubation. Samples are taken once per year. For surveillance monitoring 1 or 2 samples per 6 years are planned.

Use of equipment

species composition and growth form
For sampling plants in most cases a double rake is used connected to a rope. In some cases snorkeling is used, or an estimation with the naked eye (only possible in clear and shallow

water). Sampling bags or jars with alcohol are used for fixation for species determination (mosses, charophytes).

phytobenthos
Diatoms on the hard substrate are soaked in 10 % HCl. Small jars are used for collection.

Analysis of sample and level of determination

species composition
Most plants are determined to species level in the field, and partly validated in the laboratory. Charophytes and mosses are determined to genus or higher taxa in the field and collected for species determination.

phytobenthos
Samples are stored frozen and the samples are oxidized (NEN-EN 13946). Determination with microscope (interference/phase contrast) with 100x magnification. 200 shells are determined. Where applicable guidance NEN-EN 13946 Water quality-Guidance standard for the routine sampling and pretreatment of benthic diatoms from rivers and NEN-EN 14407 Water quality - Guidance standard for the identification and enumeration of benthic diatom samples from rivers, and their interpretation, is followed.

way of reporting basic data
There is not yet a strict procedure for transformation basic data to data ready for assessment. This is planned for June 2007.

Assessment

Data requirements

Species composition
The lakes should be typed and species list should contain a number ranging between 0 and 3 (integer). The GIG database can be used directly. That means that the data of sampling sites have to be consolidated to one list of species with their abundances.

Growth form
The lakes should be typed and the growth forms contain a percentage ranging between 0 and 100 of the potential area for each growth form.

Phytobenthos
Relative contribution of each species to the total should be reported (fraction, %).

Table 2. Example of an input file which can be used for automatically calculation of the Dutch macrophyte species metric.

LAKE	Ankeveen	Bergumer meer	Botshol	Breukeleveense plas
Type	M14	M27	M30	M14
Year	1988	2006	2006	2006
Submerged	30	10	90	10
Nympaeids	5	5	10	10
Emergent	0	0	0	0
Lemnids	1	1	1	1
Flab	0	0	0	0
Amphibious	60	80	50	90
Callitriche stagnalis Scop.	1	0	0	0

Ceratophyllum demersum L.	0	0	0	1
Chara aspera Deth. Ex Wild.	0	0	1	0
Chara connivens SALZM.	0	0	3	0
Chara contraria A. Br.	0	0	1	0
Chara globularis Thuill.	0	0	1	0
Chara hispida L.	0	0	1	0
Chara sp. L. ex Vaillant	1	0	0	0
Elodea canadensis Michx.	1	0	0	0
Elodea nuttallii (Planch.) H. St. John	0	1	0	0
Hydrocharis morsus-ranae L.	1	1	0	0
Lemna minor L.	1	0	0	0
Myriophyllum spicatum L.	0	0	0	2
Myriophyllum verticillatum L.	1	0	0	0
Najas marina L.	1	0	3	0
Nitella flexilis L. C.Ag.	1	0	0	0
Nitella mucronata (A. Br.) Miquel	1	0	0	0
Nitellopsis obtusa (Desv.) J. Groves	0	0	3	0
Nuphar lutea (L.) Sibth. & Sm.	1	1	2	2
Nymphaea alba L.	1	1	1	2
Nymphoides peltata (S. G. Gmelin) O. Kuntze	1	1	0	2
Persicaria amphibia (L.) Gray	0	0	0	1
Potamogeton acutifolius Link	1	0	1	0
Potamogeton alpinus Balbis	1	0	0	0
Potamogeton compressus L.	1	0	0	0
Potamogeton crispus L.	0	0	1	0
Potamogeton friesii Rupr.	1	0	0	0
Potamogeton lucens L.	1	0	0	0
Potamogeton natans L.	1	0	0	0
Potamogeton obtusifolius Mert. & Koch	1	1	0	0
Potamogeton pectinatus L.	0	1	1	1
Potamogeton perfoliatus L.	0	0	0	2
Potamogeton trichoides Cham. & Schltdl	1	0	0	0
Ranunculus circinatus Sibth	1	0	0	0
Stratiotes aloides L.	0	0	1	1
Utricularia vulgaris L.	1	0	0	0

Methods of calculation

species composition

For each type a list with species scores is constructed based on the expected abundance in reference conditions (Annex B). For assessment all scores are summed and compared to the reference score. All class boundaries are also expressed as percentage of the reference score. H/G: 70% G/M:40%; M/P:20% P/B:10%. The boundary percentages are transformed to EQR values, where H/G equals 0.8 and G/M equals 0.6 etc.

Table 3. The type specific reference score (M5, M14, M21, M23, M27= LCB2, M20= LCB1).

Type	M5	M14	M20	M21	M23	M27	M30	M31
Reference score	65	47	44	43	34	53	18	11

Table 4. An example for calculation of species metric for a M14 type lake.

Species in the lake	Abundance (0-3)	Score (see ANNEX B)
Potamogeton pectinatus	3	2
Potamogeton perfoliatus	1	1
Lemna minor	2	1
Chara aspera	1	3

Calculation:
1. Sum of scores = 7, reference score= 47 (see table 3)
2. EQR not transformed: 7/47=0,149 or 14.9 % of the ref score meaning POOR
3. EQR transformed (for averaging): linear transformation within class boundaries 0.2 and 0.4 (10% and 20%) gives: 0.298 (half way poor).

Growth form

From the basic data one number for each growth form is aggregated. Example: a lake of type M14 (LCB2) is covered with 500 ha by submerged macrophytes. The potential area is 1000 ha. The covered area is 50%, or 'high' status (exactly on H/G boundary, see ANNEX A). Principle of transformed EQR is the same as for species metric; in this example: 0,8

Phytobenthos

For a sample the share of 'positive' and 'negative' individuals is determined as compared to the total presence of diatoms (some species are indifferent). The species are listed in ANNEX C and the boundaries with critical shares of positive and negative species in Table 5. Example: The sum of relative abundances of positive species appears 10% and the share of negative species 40%. For the positive species status is at boundary M/P and for the negative species status is the status mid Moderate (see Table 5). Both values are assessed separately and averaged (in this case with transformed EQR of 0.45). Principle of transformed EQR is the same as for species metric.

Table 5. Boundaries for percentages of negative and positive species of Diatoms. The species listed as 'positive' or 'negative' are listed in ANNEX C.

Satus	Percentage positive species	Percentage negative species
High (mid)	70	5
High/Good	50	10
Good/Moderate	30	30
Moderate/Poor	10	50
Poor/Bad	5	70

How are reference conditions, H/G and G/M boundaries derived?

The number of reference sites is too low for setting reference values. The reference for species composition is based on the idea of having complete plant communities in reference conditions. The list of plant communities that are considered to be present in reference conditions is based on earlier work on target types in nature management (Bal *et al.*) and improved by expert judgedment. Vegetation data from the database on well developed plant communities in The Netherlands (Schaminée *et al.*) is used to list all characteristic and all frequent (>20% occurrence on relevé basis) species of these plant communities.

The weight given to species at the three abundance levels is derived from both the plant communities charactistics and expert judgment. The reference score for the sum of the scores of the species is derived from frequency data in the vegetation database, which is considered a good estimate for the probability of finding the species in a fixed amount of samples.
The fraction of species (or EQR or deviation from reference) at G/M and H/G are estimated with expert judgment, and adjustment may be needed because of too low number of reference sites. Final adjustment of the reference scores are based on intercalibration results.

The potential area where macrophytes can grow relies also on expert judgment, except for submerged macrophytes where a model technique is used (using estimates for reference tP, reference chf-a and reference light climate).
The selection of positive and negative diatoms is based on both literature and expert judgment. The boundary percentages are derived purely on expert judgment.

How well correlate the indicators with pressure indicators?

The species indicator is correlating quite well with eutrophication indicating parameters (TP, Chf-a and Secchi depth). Most clear is that the maximum value of EQR species composition is reduced at higher levels of phosphorus.

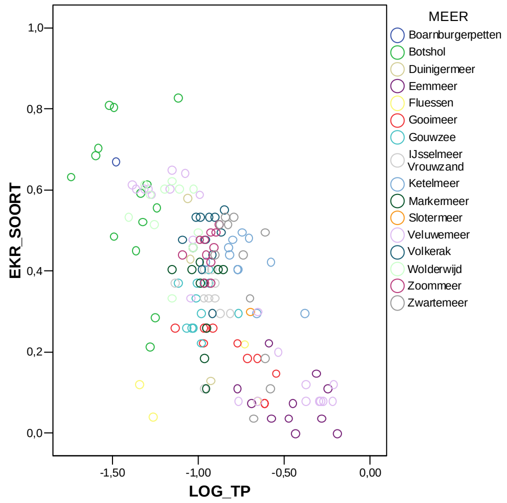


Fig 1. Relationship between Dutch EQR for species composition and total phosphorus concentration in Dutch lakes. EKR_SOORT = EQR, the picture is based on an earlier draft metric in which EQR-values are slightly lower than in the final version.

Comment [RP1]: nieuw figuur maken?

How is dealt with differences between national data and assessment vs. GIG data and assessment?

Completeness of method
The Dutch method uses species composition and growth forms cover, both of which contribute equally to the final assessment. In the GIG comparison only the species composition metric has been used because the data needed for the growth form metric is missing in the GIG database.

Data transformation to GIG data base
Data on species were 100% compatable with the GIG database format, the numerical scale for abundance of the species was equal. Some species had to be renamed after their synonyms.

Assessment transformation to the GIG data base
- The parameters for growth form cover could be derived from species abundance data but accuracy of such a transformation is far too low even for assessment in groups of classes and was therefore not performed; if the species abundance in the GIG data would have been in a 10-scale or more (best in percentage cover), the transformation could have been performed.
- Of the species in the Dutch metric, 15% were not covered by the GIG database. It is unknown wether these species were present in the original data but were not included in the database; since the metric score is correlated to number of indicator species found, a correction of 15% to the reference value and class boundaries was applied to get a true estimate for the assessment.
- Indicator species that do not exist in other MS were excluded from the metric when applied for the samples of those MS, the reference value and class boundaries were corrected accordingly.
- Species that do not exist in Dutch but have the same indicator value in other MS were included in the metric when applied for the samples of those MS, the reference value and class boundaries were corrected accordingly.

-refer to parameters which could not be assessed
-refer to species which were not present in the data base, but present in your national assessment
-refer how this is solved: eg. PL: only national data is used. eg. DE and BE: national complete method is compared with GIG method etc.
-if possible show the difference in final results

Transformations on national methodology
-especially relevant for UK, NL
-refer and be clear on which tables and values are used, and make updated tables and values where applicable.
The Dutch method was developed in 2004 with tentative reference values and class boundaries. In comparion with methods of other MS the methods was considered to stringent. December 2006 all reference values were recalculated and from then on the new values were used in the comparisons. At the Edinburg meeting it was concluded that the reference values and boundaries should even be adjusted an extra 10% less stringent. The result of this is published is the februari 2007 version of the Dutch method.
At the end of the Leiden meeting, 11 and 12 march 2007 it was concluded that the reference values and boundaries should be adjusted 15% less stringent in stead of 10%. The list of indicator species and their indicator value only changed in minor details in December 2006.

ANNEX A. Overview of growth form boundaries (% cover) for each Dutch lake type (flab=floating algae beds; Kroos=Lemna; oever=amphibious, riparian zone). The left column represent the transformed EQR. The growth form “nymphaeids” is not included in this table because this table only presents the values for the larger water types.

Comment [RP2]: complete maken?

	M5	M14	M20	M21	M23	M27	M30	M31
submers								
0,0	0	0	0	0	0	0	0	0
0,2	20	1	1	1	1	1	10	5
0,4	30	5	5	5	5	5	20	10
0,6	40	25	25	25	25	25	40	30
0,8	50	50	50	50	50	50	50	40
1,0	75	65	65	65	65	65	60	55
0,8	100	100	100	100	100	100	70	70
0,6							80	80
0,4							100	100
emers								
0,0					0			
0,2					1			
0,4					3			
0,6					5			
0,8					10			
1,0					15			
0,8					100			
flab								
0,8					0			
1,0					1		0	
0,8					5		1	
0,6					10		5	
0,4					30		10	
0,2					50		15	
kroos								
0,8					0			
1,0					0,5		0	
0,8					1		1	
0,6					2		5	
0,4					10		10	
0,2					20		20	
oever								
0,0		0	0	0		0	0	
0,2		20	20	20		20	20	
0,4		40	40	40		40	40	
0,6		60	60	60		60	60	
0,8		80	80	80		80	80	
1,0		90	90	90		90	100	0
0,8		100	100	100		100		5
0,6								10
0,4								15
0,2								20
0,0								100

ANNEX B. List of type specific characteristic species ('soort') scores. Per type and per species the number should reed as three separate scores, the first for the lowest abundance (1), the second for the intermediate abundance (2), the third for the highest abundance. Example: *Alsima gramineum* found in abundance class of 3 in type M5 will get a score of 4. The table continues at the next page.

Soort	**M5**	**M14**	**M20**	**M21**	**M23**	**M27**	**M30**	**M31**
Alisma gramineum	134							
Apium inundatum	134				122			
Azolla filiculoides	100							
Azolla mexicana	100							
Callitriche hamulata	134				122			
Callitriche hermaphroditica	134							
Callitriche obtusangula					122		134	
Callitriche platycarpa	134	122	122	122	122	122		
Ceratophyllum demersum	122	110	110	110	110	110		
Ceratophyllum submersum	122				122		134	
Chara aspera	134	134	134	134	134	134	122	
Chara baltica					134		134	134
Chara canescens					134		134	134
Chara connivens					134		134	134
Chara contraria		134	134	134	134	134		
Chara globularis	134	134	134	134	134	134	122	122
Chara major	134	134	134	134	134	134		
Chara sp.		134	134	134	134	134		
Chara vulgaris	134	134	134	134	134	134	122	122
Echinodorus ranunculoides					122			
Eleocharis acicularis	134							
Elodea canadensis	122	122	122	122		122		
Elodea nuttallii	110	110	110	110	110	110		
Fontinalis antipyretica	134	122	122	122	110	122		
Groenlandia densa	134							
Hippuris vulgaris	134							
Hottonia palustris	134	122				122		
Hydrocharis morsus-ranae	134	122	122	122		122		
Juncus bulbosus					110			
Lemna gibba	100	100	100	100		100	100	
Lemna minor	100	100	100	100	100	100	100	100
Lemna trisulca	100	110	110	110	110	110	100	100
Limosella aquatica	134							
Littorella uniflora					134			
Myriophyllum alterniflorum					122			
Myriophyllum spicatum	122	122	122	122	122	122		
Myriophyllum verticillatum	134	122	122	122		122		
Najas marina	134	122	122	122		122	134	
Nitella capillaris	134							
Nitella flexilis	122				134	134		
Nitella hyalina		134	134	134	134	134		
Nitella mucronata	134	134	134	134	134	134		
Nitella opaca	134	134	134	134	134	134	122	
Nitellopsis obtusa	122	134	134	134		134		
Nuphar lutea	134	122	122	122		122		
Nymphaea alba	134	122	122	122		122		
Nymphaea candida	122							
Nymphoides peltata	134	122				122		
Persicaria amphibia	122	122	122	122	110	122		
Potamogeton acutifolius						122		
Potamogeton alpinus	134							
Potamogeton berchtoldii		122	122	122		122		
Potamogeton coloratus					134			
Potamogeton compressus	134	122	122	122		122		
Potamogeton crispus	134	122	122	122	122	122	122	110
Potamogeton gramineus					134			
Potamogeton lucens	134	122	122	122		122		
Potamogeton mucronatus	134	122	122	122		122		
Potamogeton natans	122	122	122	122	122	122		

Soort	M5	M14	M20	M21	M23	M27	M30	M31
Potamogeton obtusifolius	134	122	122	122		122		
Potamogeton pectinatus	122	122	122	122	110	122	122	122
Potamogeton perfoliatus	134	122	122	122		122		
Potamogeton polygonifolius					122			
Potamogeton praelongus	134	122	122	122		122		
Potamogeton pusillus	134	122	122	122	110	122	110	110
Potamogeton trichoides	134	122	122	122		122		
Potamogeton x zizii		122	122	122		122		
Ranunculus aquatilis	134	122	122	122	122	122		
Ranunculus baudotii					122		134	
Ranunculus circinatus	134	122	122	122	122	122		
Ranunculus peltatus	134				122			
Riccia fluitans	100	110	110	110		110		
Ricciocarpos natans	100					110		
Ruppia cirrhosa					122		134	134
Ruppia maritima					122		134	134
Schoenoplectus lacustris	122	122	122	134	122	122		
Spirodela polyrhiza	100	100	100	100	100	100		
Stratiotes aloides	134	122				122		
Tolypella glomerata					134			
Tolypella intricata	134				134			
Tolypella prolifera	134							
Utricularia vulgaris	134	122				122		
Wolffia arrhiza						100		
Zannichellia palustris	134	122	122	122	122	122	134	134

ANNEX C. List of type specific positive (P) and negative (N) indicators of phytobenthos

soort	M5	M11	M12	M13	M14	M16	M17	M18	M20	M21	M22	M23	M24	M25	M26	M27	M30	M31
Achnanthes austriaca var. ventricosa			P	P		P	P	P						P	P	P		
Achnanthes brevipes var. intermedia			N	N			N	N							N			P
Achnanthes conspicua	P	P	P	P	P	P	P	P			P	P	P	P	P	P		
Achnanthes daui			P	P			P	P							P			
Achnanthes eutrophila	N		N	N	N		N	N				N	N		N	N		
Achnanthes exigua	P	P			P	P					P	P	P	P		P		
Achnanthes flexella			P	P			P	P							P			
Achnanthes flexella var. alpestris			P	P			P	P							P			
Achnanthes grana			P	P			P	P							P			
Achnanthes laevis			P	P			P	P							P			
Achnanthes lanceolata		N	N	N	N	N	N	N			N	N	N	N	N	N	P	
Achnanthes lanceolata ssp. biporoma			P	P			P	P							P			
Achnanthes lanceolata ssp. frequentissima			N	N			N	N							N			
Achnanthes lanceolata ssp. frequentissima var. magna			N	N			N	N							N			
Achnanthes lanceolata ssp. frequentissima var. rostratiformis			N	N			N	N							N			
Achnanthes lanceolata ssp. lanceolata var. haynaldii			N	N			N	N							N			
Achnanthes lanceolata ssp. robusta			N	N			N	N							N			
Achnanthes lanceolata ssp. rostrata			N	N			N	N							N			
Achnanthes lapidosa			P	P			P	P							P			
Achnanthes linearis			P	P		P	P	P						P	P	P		
Achnanthes lutheri			P	P			P	P							P			
Achnanthes minutissima var. scotica			P	P			P	P							P			
Achnanthes oblongella			P	P			P	P							P			
Achnanthes petersenii			P	P			P	P						P	P	P		
Achnanthes rupestoides			P	P			P	P							P			
Achnanthes rupestris			P	P			P	P							P			
Achnanthes subsalsa			N	N			N	N							N			
Achnanthes suchlandtii			P	P			P	P							P			
Achnanthes ventralis var. crassa			P	P			P	P							P			
Achnanthidium affine	P	P			P	P			P	P	P	P	P	P		P	P	
Achnanthidium kryophila			P	P			P	P							P			
Achnanthidium kryophila			P	P			P	P							P			
Achnanthidium thermale			P	P			P	P							P			
Achnanthidium ventralis			P	P			P	P							P			
Actinocyclus normanii		N				N												
Actinocyclus normanii morfotype subsalsus			N	N			N	N							N			
Amphipleura kriegeriana			P	P			P	P							P			
Amphipleura pellucida			N	N			N	N							N			
Amphora coffeaeformis																		P
Amphora fogediana			P	P			P	P							P			
Amphora holsatica																		P
Amphora libyca	P	P	N	N	P	P	N	N	P	P	P	P	P	P	N	P	P	
Amphora montana			N	N			N	N							N			
Amphora ovalis		N	N	N	N	N	N	N			N	N	N	N	N	N	N	
Amphora pediculus	P	P	N	N	P	P	N	N			P	P	P	P	N	P	P	
Amphora veneta	N	N	N	N	N	N	N	N			N	N	N	N	N	N	P	
Anomoeoneis sphaerophora	N	N	N	N	N	N	N	N			N	N	N	N	N	N		
Anomoeoneis vitrea f. lanceolata			P	P			P	P							P			
Asterionella formosa			N	N		P	N	N	P	P					N			
Asterionella ralfsii			P	P			P	P							P			
Aulacoseira alpigena			P	P			P	P							P			
Aulacoseira ambigua	N	N	N	N	N	N	N	N			N	N	N	N	N	N		
Aulacoseira distans			P	P			P	P							P			
Aulacoseira granulata	N	N	N	N	N	N	N	N		N	N	N	N	N	N	N		
Aulacoseira islandica	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Aulacoseira italica			N	N			N	N	P	P					N			

soort	M5	M11	M12	M13	M14	M16	M17	M18	M20	M21	M22	M23	M24	M25	M26	M27	M30	M31
Aulacoseira subarctica	P	P			P	P					P	P	P	P		P		
Bacillaria paxillifer			N	N			N	N		N					N			P
Berkeleya rutilans																		P
Brachysira brebissonii			P	P			P	P							P			
Brachysira neoxilis											P							
Brachysira serians			P	P			P	P							P			
Brachysira styriaca			P	P			P	P							P			
Brachysira vitrea	P	P	P	P	P	P	P	P	P		P	P	P	P	P	P		
Caloneis amphisbaena	N	N	N	N	N	N	N	N			N	N	N	N	N	N		
Caloneis bacillum	P	P	N	N	P	P	N	N	P	P	P	P	P	P	N	P		
Caloneis limosa	P	P			P	P					P	P	P	P		P		
Caloneis permagna			N	N			N	N							N			
Caloneis silicula			N	N			N	N							N			
Caloneis silicula var. truncata			N	N			N	N							N			
Caloneis undulata			P	P			P	P							P			
Campylodiscus clypeus													P					
Chaetoceros muelleri																	N	
Cocconeis pediculus	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Cocconeis placentula	P	P	N	N	P	P	N	N	P	P	P	P	P	P	N	P		
Cocconeis placentula var. euglypta			N	N			N	N							N			
Cocconeis placentula var. lineata			N	N			N	N							N		P	
Craticula accomoda	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N		
Craticula cuspidata	N	N	N	N	N	N	N	N			N	N	N	N	N	N		
Craticula halophila	N	N	N	N	N	N	N	N			N	N	N	N	N	N	P	
Ctenophora pulchella	N	N	N	N	N	N	N	N			N	N	N	N	N	N	P	
Cyclostephanos dubius	N	N	N	N	N	N	N	N			N	N	N	N	N	N		
Cyclotella atomus	N	N	N	N	N	N	N	N			N	N	N	N	N	N		
Cyclotella meneghiniana	N	N	N	N	N	N	N	N			N	N	N	N	N	N		
Cyclotella ocellata			N	N			N	N							N			
Cyclotella pseudostelligera			N	N			N	N							N			
Cyclotella radiosa			N	N			N	N							N			
Cyclotella striata			N	N			N	N							N			
Cymatopleura elliptica	P	P			P	P					P	P	P	P		P		
Cymatopleura librile	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Cymatosira belgica																	P	
Cymbella affinis	P	P			P	P					P	P	P	P		P		
Cymbella aspera	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Cymbella cesatii			P	P			P	P			P		P		P			
Cymbella cistula	P	P	N	N	P	P	N	N			P	P	P	P	N	P	P	
Cymbella cuspidata	P	P			P	P					P	P	P	P		P		
Cymbella cymbiformis	P	P	P	P	P	P	P	P		P	P	P	P	P	P	P		
Cymbella descripta			P	P			P	P							P			
Cymbella ehrenbergii	P	P	P	P	P	P	P	P			P	P	P	P	P	P		
Cymbella falaisensis			P	P			P	P			P		P		P			
Cymbella falaisensis var. lanceola			P	P			P	P							P			
Cymbella gaeumannii			P	P			P	P							P			
Cymbella gracilis			P	P			P	P							P			
Cymbella hebridica			P	P			P	P							P			
Cymbella helmckei	P	P			P	P					P	P	P	P		P		
Cymbella helvetica	P	P	P	P	P	P	P	P			P	P	P	P	P	P		
Cymbella heteropleura			P	P			P	P							P			
Cymbella lanceolata	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Cymbella leptoceros	P	P	P	P	P	P	P	P			P	P	P	P	P	P		
Cymbella mesiana	P	P			P	P					P	P	P	P		P		
Cymbella microcephala	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		
Cymbella naviculiformis	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Cymbella proxima	P	P			P	P					P	P	P	P		P		
Cymbella subaequalis			P	P			P	P							P			
Cymbella subcuspidata			P	P			P	P							P			
Cymbella tumida	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Cymbella tumidula	P	P			P	P					P	P	P	P		P		

soort	M5	M11	M12	M13	M14	M16	M17	M18	M20	M21	M22	M23	M24	M25	M26	M27	M30	M31
Delphineis surirella			N	N			N	N							N		P	
Denticula kuetzingii	P								P	P	P	P	P	P		P		
Diatoma mesodon			P	P			P	P							P			
Diatoma moniliformis	P	P			P	P					P	P	P	P		P		
Diatoma problematica																	N	
Diatoma tenuis	N	N	N	N	N	N	N	N			N	N	N	N	N	N	P	
Diatoma vulgaris	P	P	N	N	P	P	N	N	P	P	P	P	P	P	N	P		
Diatoma vulgaris var. linearis			N	N			N	N							N			
Diploneis didyma			N	N			N	N							N			
Diploneis elliptica	P	P			P	P					P	P	P	P		P		
Diploneis oblongella			P	P			P	P							P			
Diploneis ovalis	P	P			P	P					P	P	P	P		P		
Diploneis petersenii			P	P			P	P							P			
Diploneis pseudovalis																	N	
Encyonema caespitosum	N	N	N	N	N	N	N	N			N	N	N	N	N	N		
Encyonema perpusillum			P	P			P	P							P			
Encyonema prostratrum	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Encyonema silesiacum	N	N	N	N	N	N	N	N			N	N	N	N	N	N		
Encyonopsis krammeri			P	P			P	P							P			
Encyonopsis subminuta	P	P	P	P	P	P	P	P			P	P	P	P	P	P		
Entomoneis paludosa	N	N			N	N					N	N	N	N		N		
Epithemia adnata	P	P	N	N	P	P	N	N	P	P	P	P	P	P	N	P	P	
Epithemia sorex	P	P	N	N	P	P	N	N			P	P	P	P	N	P	P	
Epithemia turgida	P	P	N	N	P	P	N	N	P	P	P	P	P	P	N	P		
Eunotia arculus			P	P			P	P							P			
Eunotia arcus	P	P	P	P	P	P	P	P		P	P	P	P	P	P	P		
Eunotia arcus var. bidens			P	P			P	P							P			
Eunotia bilunaris	P	P			P	P					P	P	P	P		P		
Eunotia circumborealis			P	P			P	P							P			
Eunotia denticulata			P	P			P	P							P			
Eunotia diodon			P	P			P	P							P			
Eunotia elegans			P	P			P	P							P			
Eunotia exigua			Z	Z			Z	Z						N	Z	N		
Eunotia fallax			P	P			P	P							P			
Eunotia fallax var. groenlandica			P	P			P	P							P			
Eunotia flexuosa			P	P			P	P							P			
Eunotia formica	P	P			P	P				P	P	P	P	P		P		
Eunotia glacialis										P								
Eunotia glacialis	P	P	P	P	P	P	P	P			P	P	P	P	P	P		
Eunotia iatriaensis			P	P			P	P							P			
Eunotia implicata	P	P			P	P					P	P	P	P		P		
Eunotia intermedia			P	P			P	P							P			
Eunotia kocheliensis			P	P			P	P							P			
Eunotia meisteri			P	P			P	P							P			
Eunotia microcephala			P	P			P	P							P			
Eunotia minor	P	P			P	P					P	P	P	P		P		
Eunotia monodon	P	P			P	P					P	P	P	P		P		
Eunotia naegelii			P	P			P	P							P			
Eunotia nymanniana			P	P			P	P							P			
Eunotia parallela			P	P			P	P							P			
Eunotia parallela var. angusta			P	P			P	P							P			
Eunotia pectinalis	P	P			P	P			P	P	P	P	P	P		P		
Eunotia praerupta			P	P			P	P		P					P			
Eunotia pseudopectinalis			P	P			P	P							P			
Eunotia rhynchocephala			P	P			P	P							P			
Eunotia septentrionalis			P	P			P	P							P			
Eunotia serra			P	P			P	P							P			
Eunotia serra var. diadema			P	P			P	P							P			
Eunotia serra var. tetraodon			P	P			P	P							P			
Eunotia soleirolii	P	P			P	P					P	P	P	P		P		
Eunotia sudetica			P	P			P	P							P			

soort	M5	M11	M12	M13	M14	M16	M17	M18	M20	M21	M22	M23	M24	M25	M26	M27	M30	M31
Eunotia tenella			P	P			P	P							P			
Eunotia vanheurckii			P	P			P	P							P			
Eunotia varioundulata			P	P			P	P							P			
Eunotia veneris			P	P			P	P							P			
Fallacia monoculata			N	N			N	N							N			
Fallacia pygmea			N	N			N	N							N			P
Fallacia subhamulata			N	N			N	N							N			
Fragilaria acidoclinata			P	P			P	P							P			
Fragilaria biceps	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Fragilaria bidens	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Fragilaria capucina	P	P	N	N	P	P	N	N		P	P	P	P	P	N	P	P	
Fragilaria capucina var. austriaca			P	P			P	P							P			
Fragilaria capucina var. capitellata			N	N			N	N							N			
Fragilaria capucina var. gracilis			P	P			P	P							P			
Fragilaria capucina var. rumpens			P	P			P	P							P			
Fragilaria capucina var. vaucheriae	N	N	N	N	N	N	N	N			N	N	N	N	N	N	P	
Fragilaria construens	P	P	N	N	P	P	N	N	P	P	P	P	P	P	N	P		
Fragilaria construens f. binodis			N	N			N	N							N			
Fragilaria construens f. venter			N	N			N	N							N			
Fragilaria crotonensis	P	P	N	N	P	P	N	N	P	P	P	P	P	P	N	P		
Fragilaria delicatissima	P	P	P	P	P	P	P	P			P	P	P	P	P	P		
Fragilaria dilatata	P	P			P	P					P	P	P	P		P		
Fragilaria exigua			P	P			P	P			P		P		P			
Fragilaria famelica	P	P	N	N	P	P	N	N			P	P	P	P	N	P	P	
Fragilaria famelica var. littoralis			N	N			N	N							N			
Fragilaria fasciculata	N	N	N	N	N	N	N	N			N	N	N	N	N	N		P
Fragilaria nanana	P	P	P	P	P	P	P	P			P	P	P	P	P	P		
Fragilaria oldenburgiana			P	P			P	P							P			
Fragilaria parasitica	P	P	N	N	P	P	N	N	P	P	P	P	P	P	N	P		
Fragilaria parasitica var. subconstricta			N	N			N	N							N			
Fragilaria sopotensis			N	N			N	N							N			
Fragilaria tenera	P	P	P	P	P	P	P	P			P	P	P	P	P	P		
Fragilaria ulna	N	N	N	N	N	N	N	N			N	N	N	N	N	N	P	
Fragilaria ulna group angustissima			N	N			N	N							N			
Fragilaria ulna var. acus			N	N			N	N							N			
Fragilaria virescens			P	P			P	P					P		P			
Fragilariforma bicapitata	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Fragilariforma constricta			P	P			P	P							P			
Frustulia vulgaris	P	P	N	N	P	P	N	N	P	P	P	P	P	P	N	P		
Gomphonema acuminatum	P	P	N	N	P	P	N	N		P	P	P	P	P	N	P		
Gomphonema affine			N	N			N	N	P	P					N			
Gomphonema augur	N	N	N	N	N	N	N	N	P	P	N	N	N	N	N	N		
Gomphonema clavatum									P	P								
Gomphonema clavatum	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Gomphonema dichotomum	P	P	N	N	P	P	N	N	P	P	P	P	P	P	N	P		
Gomphonema exiguum var. minutissimum																		P
Gomphonema gracile	P	P	P	P	P	P	P	P			P	P	P	P	P	P	P	
Gomphonema hebridense	P	P	P	P	P	P	P	P			P	P	P	P	P	P		
Gomphonema insigne	P	P			P	P					P	P	P	P		P		
Gomphonema micropus	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Gomphonema minutum	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Gomphonema olivaceum	P	P	N	N	P	P	N	N			P	P	P	P	N	P	P	
Gomphonema olivaceum var. olivaceoides			N	N			N	N							N			
Gomphonema parvulum	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	
Gomphonema parvulum f. saprophilum			N	N			N	N							N			
Gomphonema parvulum var. exilissimum			P	P			P	P							P			
Gomphonema parvulum var. parvulius			P	P			P	P							P			
Gomphonema pratense	P	P			P	P					P	P	P	P		P		
Gomphonema productum			N	N			N	N							N			
Gomphonema pseudoaugur	N	N	N	N	N	N	N	N			N	N	N	N	N	N		
Gomphonema pumilum	P	P			P	P					P	P	P	P		P	P	

soort	M5	M11	M12	M13	M14	M16	M17	M18	M20	M21	M22	M23	M24	M25	M26	M27	M30	M31
Gomphonema sarcophagus	P	P			P	P			P	P	P	P	P	P		P		
Gomphonema truncatum	P	P	N	N	P	P	N	N	P	P	P	P	P	P	N	P	P	
Gomphonema vibrio	P	P	N	N	P	P	N	N	P	P	P	P	P	P	N	P		
Gyrosigma acuminatum	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Gyrosigma attenuatum	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Hantzschia amphioxys	N	N			N	N					N	N	N	N		N		
Hantzschia elongata			P	P			P	P							P			
Karayevia clevei	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		
Karayevia laterostrata			P	P			P	P							P			
Kobayasiella micropunctata			P	P			P	P							P			
Kobayasiella parasubtillisima			P	P			P	P							P			
Kolbesia ploenensis	P	P			P	P					P	P	P	P		P		
Lemnicola hungarica	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N		N
Luticola cohnii			N	N			N	N							N			
Luticola dapaliformis	N	N	N	N	N	N	N	N	N		N	N	N	N	N	N	N	
Luticola mutica	N	N	N	N	N	N	N	N			N	N	N	N	N	N		
Luticola nivalis			N	N			N	N							N			
Mastogloia pumila																		P
Melosira moniliformis																		P
Melosira nummuloides																		P
Melosira varians	N	N	N	N	N	N	N	N			N	N	N	N	N	N		
Meridion circulare			N	N			N	N							N			
Navicula absoluta			N	N			N	N							N			
Navicula angusta			P	P			P	P							P			
Navicula arenaria																		P
Navicula atomus	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N		
Navicula atomus var. excelsa			N	N			N	N							N			
Navicula atomus var. permitis			N	N			N	N							N			N
Navicula bryophila			P	P			P	P							P			
Navicula cancellata var. retusa			N	N			N	N							N			
Navicula capitata	N	N	N	N	N	N	N	N	P	P	N	N	N	N	N	N		
Navicula capitata var. hungarica			N	N			N	N							N		P	
Navicula capitatoradiata	N	N	N	N	N	N	N	N			N	N	N	N	N	N		
Navicula cari			N	N			N	N							N			
Navicula cariocincta			N	N			N	N							N			
Navicula catalanogermanica			N	N			N	N							N			
Navicula cincta		N	N	N	N	N	N	N			N	N	N	N	N	N	P	
Navicula crucicula			N	N			N	N							N			
Navicula cryptocephala	N	N	N	N	N	N	N	N			N	N	N	N	N	N		
Navicula cryptolyra																		P
Navicula cryptotenella			N	N			N	N							N		P	
Navicula cryptotenelloides	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Navicula decussis			N	N			N	N							N			
Navicula difficillima			P	P			P	P							P			
Navicula digitoradiata			N	N			N	N							N			
Navicula elginensis var. cuneata			N	N			N	N							N			
Navicula erifuga			N	N			N	N							N			
Navicula evanida			P	P			P	P							P			
Navicula festiva			P	P			P	P							P			
Navicula fossalis			N	N			N	N							N			
Navicula gallica var. perpusilla			P	P			P	P							P			
Navicula graciloides	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Navicula gregaria	N	N	N	N	N	N	N	N			N	N	N	N	N	N	P	
Navicula heimansioides			P	P			P	P							P			
Navicula integra	N	N	N	N	N	N	N	N			N	N	N	N	N	N		
Navicula jaernefeltii			P	P			P	P							P			
Navicula joubaudii	N	N	N	N	N	N	N	N			N	N	N	N	N	N		
Navicula krasskei			P	P			P	P							P			
Navicula lacunolaciniata			N	N			N	N							N			
Navicula lanceolata	N	N	N	N	N	N	N	N			N	N	N	N	N	N	P	
Navicula leptostriata			P	P			P	P							P			

soort	M5	M11	M12	M13	M14	M16	M17	M18	M20	M21	M22	M23	M24	M25	M26	M27	M30	M31
Navicula lundii	P	P			P	P					P	P	P	P		P		
Navicula maceria			P	P			P	P							P			
Navicula margalithii			N	N			N	N							N		P	
Navicula mediocris			P	P			P	P							P			
Navicula menisculus	P	P	N	N	P	P	N	N			P	P	P	P	N	P		P
Navicula menisculus var. grunowii			N	N			N	N							N			
Navicula meniscus			N	N			N	N							N			
Navicula minima	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	
Navicula minuscula			P	P			P	P							P			
Navicula minuscula var. muralis			N	N			N	N							N			
Navicula minusculoides			N	N			N	N							N			N
Navicula molestiformis			N	N			N	N	N	N					N			N
Navicula mutica var. ventricosa			N	N			N	N							N			
Navicula oblonga	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Navicula pavillardii																		P
Navicula phyllepta																		P
Navicula placentula	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Navicula protracta			N	N			N	N							N			
Navicula pseudolanceolata			P	P			P	P							P			
Navicula pseudoscutiformis			N	N			N	N	P	P					N			
Navicula pseudoventralis			P	P			P	P							P			
Navicula pupula	N	N	N	N	N	N	N	N	P	P	N	N	N	N	N	N		
Navicula pupula f. capitata			N	N			N	N							N			
Navicula radiosa	P	P	N	N	P	P	N	N	P	P	P	P	P	P	N	P	P	
Navicula radiosafallax	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Navicula recens			N	N			N	N							N			P
Navicula reichardtiana	P	P			P	P					P	P	P	P		P		
Navicula reinhardtii	P	P	N	N	P	P	N	N		P	P	P	P	P	N	P		
Navicula rhynchocephala	P	P	N	N	P	P	N	N			P	P	P	P	N	P	P	
Navicula rhynchocephala var. amphiceros	N	N	N	N	N	N	N	N			N	N	N	N	N	N		
Navicula riparia			N	N			N	N							N			
Navicula salinarum	N	N	N	N	N	N	N	N			N	N	N	N	N	N	P	
Navicula saprophila			N	N			N	N	N						N			N
Navicula schroeteri			N	N			N	N							N			
Navicula semen			P	P			P	P							P			
Navicula seminulum									N	N								
Navicula slesvicensis	N	N	N	N	N	N	N	N			N	N	N	N	N	N	P	
Navicula soehrensis			P	P			P	P							P			
Navicula soehrensis var. hassiaca			P	P			P	P							P			
Navicula soehrensis var. muscicola			P	P			P	P							P			
Navicula subminuscula	N	N	N	N	N	N	N	N			N	N	N	N	N	N		N
Navicula subrotundata			P	P			P	P							P			
Navicula subtilissima			P	P			P	P							P			
Navicula tenelloides	P	P	P	P	P	P	P	P			P	P	P	P	P	P	N	
Navicula tridentula			P	P			P	P							P			
Navicula tripunctata	P	P	N	N	P	P	N	N	P	P	P	P	P	P	N	P	P	
Navicula trivialis	N	N	N	N	N	N	N	N			N	N	N	N	N	N		
Navicula variostriata			P	P			P	P							P			
Navicula veneta	N	N	N	N	N	N	N	N			N	N	N	N	N	N	P	
Navicula ventraloconfusa			P	P			P	P							P			
Navicula viridula																	N	
Navicula viridula var. rostellata			N	N			N	N							N			
Neidium affine			N	N			N	N		P					N			
Neidium affine var. longiceps			P	P			P	P							P			
Neidium alpinum			P	P			P	P							P			
Neidium alpinum var. quadripunctatum			P	P			P	P							P			
Neidium ampliatum			N	N			N	N							N			
Neidium binodis			N	N			N	N							N			
Neidium bisulcatum			P	P			P	P							P			
Neidium carteri			P	P			P	P							P			
Neidium densestriatum			P	P			P	P							P			

soort	M5	M11	M12	M13	M14	M16	M17	M18	M20	M21	M22	M23	M24	M25	M26	M27	M30	M31
Neidium dubium	P	P	N	N	P	P	N	N	P	P	P	P	P	P	N	P		
Neidium hercynicum			P	P			P	P							P			
Neidium iridis			N	N			N	N	P	P					N			
Neidium productum														P		P		
Nitzschia acicularis	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N		N
Nitzschia acidoclinata			P	P			P	P	P	P				P	P	P		
Nitzschia agnita																	P	
Nitzschia amphibia	N	N	N	N	N	N	N	N			N	N	N	N	N	N	P	
Nitzschia angustiforaminata	N	N			N	N			N		N	N	N	N		N	P	
Nitzschia archibaldii			N	N			N	N	N	N				N	N	N	P	
Nitzschia aurariae																		P
Nitzschia bremensis														P		P		
Nitzschia capitellata	N	N			N	N			N	N	N	N	N	N		N		P
Nitzschia capitellata group tenuirostris/subcapitellata			N	N			N	N							N			
Nitzschia communis	N	N			N	N			N		N	N	N	N		N		
Nitzschia debilis			N	N			N	N							N			
Nitzschia dissipata	P	P	N	N	P	P	N	N	P	P	P	P	P	P	N	P	P	
Nitzschia dissipata var. media			N	N			N	N							N			
Nitzschia dubia			N	N			N	N							N			
Nitzschia filiformis	N	N	N	N	N	N	N	N			N	N	N	N	N	N		
Nitzschia fonticola	P	P	N	N	P	P	N	N	P	P	P	P	P	P	N	P	P	
Nitzschia frequens																	N	
Nitzschia frequens			N	N			N	N							N			
Nitzschia frustulum	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	
Nitzschia frustulum var. bulnheimiana			N	N			N	N							N			
Nitzschia graciliformis	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Nitzschia gracilis	P	P	N	N	P	P	N	N	P	P	P	P	P	P	N	P		
Nitzschia heufleriana	P	P			P	P					P	P	P	P		P		
Nitzschia inconspicua	N	N	N	N	N	N	N	N			N	N	N	N	N	N	P	
Nitzschia intermedia	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Nitzschia lacuum	P	P	P	P	P	P	P	P			P	P	P	P	P	P		
Nitzschia levidensis group salinarum			N	N			N	N							N			
Nitzschia linearis	P	P	N	N	P	P	N	N	P	P	P	P	P	P	N	P		
Nitzschia microcephala	N	N	N	N	N	N	N	N			N	N	N	N	N	N	P	
Nitzschia nana									P	P				P		P		
Nitzschia palea	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	
Nitzschia paleacea	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	
Nitzschia paleaeformis			N	N			N	N							N			
Nitzschia perminuta																		P
Nitzschia perminuta			P	P			P	P						P	P	P		
Nitzschia pseudofonticola			N	N			N	N							N			
Nitzschia pusilla	P	P	N	N	P	P	N	N			P	P	P	P	N	P		P
Nitzschia recta	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Nitzschia sigma			N	N			N	N							N		P	
Nitzschia sigmoidea	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Nitzschia sinuata									P	P								
Nitzschia sociabilis	P	P			P	P					P	P	P	P		P		
Nitzschia subacicularis	N	N	N	N	N	N	N	N			N	N	N	N	N	N		
Nitzschia supralitorea	N	N	N	N	N	N	N	N			N	N	N	N	N	N	P	
Nitzschia terrestris														N		N		
Nitzschia tubicola			N	N			N	N							N			
Nitzschia tubicola group gandersheimiensis			N	N			N	N	N	N					N			
Nitzschia umbonata									N	N								
Nitzschia vermicularis	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Nitzschia vitrea			N	N			N	N							N			
Opephora mutabilis																		P
Oxyneis binalis			P	P			P	P							P			
Peronia fibula			P	P			P	P							P			
Pinnularia borealis										P				P		P		
Pinnularia braunii			P	P			P	P							P			

soort	M5	M11	M12	M13	M14	M16	M17	M18	M20	M21	M22	M23	M24	M25	M26	M27	M30	M31
Pinnularia brebissonii	N	P				P							P	P				
Pinnularia divergens			P	P			P	P							P			
Pinnularia divergentissima var. minor			P	P			P	P							P			
Pinnularia gibba	P	P			P	P					P	P	P	P		P		
Pinnularia interrupta			P	P			P	P							P			
Pinnularia major			N	N			N	N	P	P					N			
Pinnularia mesolepta									P	P				P		P		
Pinnularia microstauron	P	P			P	P					P	P	P	P		P		
Pinnularia nobilis			P	P			P	P							P			
Pinnularia obscura			P	P			P	P							P			
Pinnularia polyonca			P	P			P	P							P			
Pinnularia rupestris														P		P		
Pinnularia silvatica														P		P		
Pinnularia sinistra														P		P		
Pinnularia stomatophora			P	P			P	P							P			
Pinnularia subgibba														P		P		
Pinnularia viridiformis	P	P			P	P					P	P	P	P		P		
Placoneis clementis	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Placoneis elginensis	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Placoneis gastrum	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Placoneis pseudanglica			N	N			N	N	P	P					N			
Planothidium delicatulum	N	N	N	N	N	N	N	N			N	N	N	N	N	N		P
Planothidium oestrupii			P	P			P	P							P			
Planothidium peragallii			P	P			P	P							P			
Psammothidium altaicum			P	P			P	P							P			
Psammothidium bioretii			P	P			P	P							P			
Psammothidium grishunum f. daonensis			P	P			P	P							P			
Psammothidium lauenburgianaum			P	P			P	P							P			
Psammothidium levanderi			P	P			P	P							P			
Psammothidium marginulatum			P	P			P	P						P	P			
Psammothidium pseudoswazi			P	P			P	P							P			
Psammothidium rossii			P	P			P	P							P			
Psammothidium subatomoides			P	P			P	P							P			
Pseudostaurosira brevistriata	P	P	P	P	P	P	P	P			P	P	P	P	P	P		
Reimeria sinuata									P									
Rhaphoneis amphiceros			N	N			N	N							N			
Rhoicosphenia abbreviata	P	P	N	N	P	P	N	N	P		P	P	P	P	N	P	P	
Rhopalodia constricta																	N	
Rhopalodia gibba	P	P	N	N	P	P	N	N			P	P	P	P	N	P	P	
Rhopalodia operculata																	N	
Rossithidium petersennii			P	P			P	P						P	P	P		
Sellaphora americana	P	P	P	P	P	P	P	P			P	P	P	P	P	P		
Sellaphora bacillum	P	P	N	N	P	P	N	N	P	P	P	P	P	P	N	P		
Sellaphora seminulum	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	
Simonsenia delognei																	N	
Skeletonema potamos	N	N			N	N					N	N	N	N		N		
Skeletonema subsalsum	N	N	N	N	N	N	N	N			N	N	N	N	N	N		
Stauroneis anceps			N	N			N	N	P	P				P	N	P		
Stauroneis anceps var. gracilis			P	P			P	P							P			
Stauroneis anceps var. hyalina			P	P			P	P							P			
Stauroneis anceps var. siberica			P	P			P	P							P			
Stauroneis gracilior			P	P			P	P							P			
Stauroneis kriegeri	P	P	N	N	P	P	N	N	P	P	P	P	P	P	N	P		
Stauroneis legumen			N	N			N	N	P	P					N			
Stauroneis obtusa			P	P			P	P							P			
Stauroneis phoenicenteron	P	P	N	N	P	P	N	N	P	P	P	P	P	P	N	P		
Stauroneis smithii	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Staurosira elliptica	P	P	N	N	P	P	N	N	P	P	P	P	P	P	N	P		
Staurosirella berolinensis	N	N			N	N					N	N	N	N		N		
Staurosirella leptostauron	P	P	P	P	P	P	P	P			P	P	P	P	P	P		
Staurosirella pinnata	P	P	N	N	P	P	N	N			P	P	P	P	N	P		

soort	M5	M11	M12	M13	M14	M16	M17	M18	M20	M21	M22	M23	M24	M25	M26	M27	M30	M31
Stenopterobia curvula			P	P			P	P							P			
Stenopterobia delicatissima			P	P			P	P							P			
Stenopterobia densestriata			P	P			P	P							P			
Stephanodiscus binderanus	N	N			N	N					N	N	N	N		N		
Stephanodiscus hantzschii	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	
Stephanodiscus medius			N	N			N	N							N			
Stephanodiscus minutulus	N	N			N	N			N		N	N	N	N		N		
Stephanodiscus neoastraea	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Stephanodiscus parvus	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	
Surirella amphioxys	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Surirella angusta	P	P	N	N	P	P	N	N			P	P	P	P	N	P		
Surirella biseriata	P	P			P	P					P	P	P	P		P		
Surirella brebissonii	N	N			N	N					N	N	N	N		N		
Surirella brebissonii var. kuetzingii			N	N			N	N							N			
Surirella brightwellii var. baltica																	N	
Surirella capronii	P	P			P	P				P	P	P	P	P		P		
Surirella minuta	N	N	N	N	N	N	N	N			N	N	N	N	N	N	N	
Surirella ovalis			N	N			N	N							N			
Surirella roba			P	P			P	P							P			
Surirella robusta	P	P			P	P					P	P	P	P		P		
Surirella splendida									P	P								
Tabellaria binalis var. elliptica			P	P			P	P							P			
Tabellaria fenestrata			N	N		P	N	N		P					N			
Tabellaria flocculosa	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P		
Thalassiosira bramaputrae			N	N			N	N							N			
Thalassiosira guillardii																	N	
Thalassiosira pseudonana	N	N	N	N	N	N	N	N			N	N	N	N	N	N	N	
Thalassiosira tenera			N	N			N	N							N			
Thalassiosira weissflogii	N	N	N	N	N	N	N	N			N	N	N	N	N	N	N	
Tryblionella apiculata	N	N	N	N	N	N	N	N			N	N	N	N	N	N		P
Tryblionella calida	N	N	N	N	N	N	N	N			N	N	N	N	N	N		
Tryblionella gracilis			N	N			N	N							N			
Tryblionella hungarica			N	N			N	N							N		P	
Tryblionella levidensis	N	N	N	N	N	N	N	N			N	N	N	N	N	N		
Tryblionella navicularis			N	N			N	N							N			

Case: BE-FL

Status: input for intercalibration exercise

For full details see Schneiders *et al.* (2004) and Leyssen *et al.* (2005). Internet source: http://www.instnat.be/content/page.asp?pid=PUB_Rapporten.

Indicators

Macrophyte taxonomic composition
Species composition covers all charophytes and all angiosperms classified as hydrophyte or phreatophyte, as well as selected aphreatophytes, mosses, liverworts and non-charophyte algae (*Enteromorpha*, *Hydrodyction*); cyanobacterial films and filamentous algae are also considered. All taxa included in the assessment are listed in Annex 1. Fourteen growth forms are distinguished: lemnid, large pleustophyte (incl. stratiotid, hydrocharitid, salvinid), submerse non-rooting (incl. ceratophyllid, ricciellid and some aquatic mosses), charid, magnopotamid, other rooting caulescent hydrophyte (incl. parvopotamid, myriophyllid, elodeid, batrachid and peplid), nymphaeid, vallisnerid, isoetid, small and medium-sized riparian plant, large monocotyledonous riparian plant, peat moss, cyanobacterial film.

Macrophyte abundance
The abundance of macrophytes in the aquatic and riparian zone are surveyed separately. The aquatic vegetation of the entire water body is considered to a depth of 4 m for deep (stratified) waters and to a depth of 2 m for shallow (fully mixed) waters; parts where vegetation growth is limited by substrate conditions (e.g. concrete flooring, very steep inclination) or intense shading may be excluded. The riparian vegetation is considered along the entire lake margin in the emerged zone between the water level and normal winter level; parts where plant growth is hampered by substrate may be excluded. The water surface of the part shallower than 4 or 2 m, respectively, is divided into surface segments with more or less homogeneous vegetation, morphology, substrate and adjacent land use. The relative surface area of these segments is determined (by GIS) and used as a weighting factor for the contribution of each segment to calculate the EQRs. Similar to the water surface, the emerged zone is divided into stretches; these are weighted by their length. Species composition and abundance of individual macrophytes are estimated in all segments and stretches using the scale shown in Table 1.

Table 1. Abundance scale for individual lake macrophytes in BE-FL.

rare and occasional	1	very few individuals, insignificant quantity
frequent	2	larger number of individuals, low quantity
abundant	3	large number of individuals, substantial quantity
co-dominant	4	large number of individuals, several species ± equally represented with very substantial quantity
dominant	5	large number of individuals, only species with very substantial quantity

Additionaly, the total abundance of submerged vegetation is estimated for each segment as in Table 2, and the growth forms occurring in the water are listed.

Table 2. Abundance scale for submerged lake vegetation in BE-FL.

0	(nearly) absent
1	scarce
2	(fairly) abundant but not filling the water column
3	filling the entire water column *or* filamentous algae covering most part of bottom or surface

Bacterial tufts
Presence is noted (cf. metric 'growth forms' for assessment).

Summary
The EQR is derived from 4 complementary metrics, all taking the form of separate EQRs (scaled 0-1):

- relative abundance of type-specific taxa,
- relative abundance of disturbance indicators, selected according to type,
- diversity of growth forms relative to expectations, specified according to type, and,
- development of submerse vegetation.

The relative abundance of type-specific taxa and disturbance indicators are calculated for the riparian zone and for the aquatic zone; diversity of growth forms and development of submerged vegetation are only relevant for the aquatic zone. All the metrics are considered equally important and are combined by taking the lowest value for any one of them as the final EQR ('one out, all out'). A standard list of macrophytes is used for the calculation of the first two metrics (see Annex 1). Macrophyte assessment is not constrained by requiring the presence of a minimum number of species or an abundance treshold. Macrophytes and phytobenthos are assessed independently of each other and considered on an equal basis using the ‘one out, all out’ principle.

Monitoring

Strategy
The entire water body is considered, including its riparian zone.

When, frequency?
Once a year. Preferably in summer (mid June to August), possibly extending into early Autumn for certain sites. Depending on the vegetation composition or observed phenology, an additional visit may be made in spring (May) or early summer to allow complementary observations.

Equipment
Vegetation is surveyed from the shore, wading through the water, and/or from a boat, whatever is most appropriate or possible. A 50 cm broad mesh-covered rake on a telescopic handle (up to 4 m long) or a similar double-sided rake fixed to a 20 m rope are used where necessary. If necessary, a variable number of fixed transects, chosen to cover spatial variation as completely as possible, are sampled in deeper parts from a motor boat or by wading. Transect observations are supplemented by point observations to asses distribution patterns. If a boat is used in deep water, the double rake is thrown perpendicular to the transect twice or three times on each side every 10 or 20 m; transect width is ca. 10 m.

Analysis
Identification is done in the field, if possible, using appropriate keys, magnifying glass,... If necessary, this is validated or completed in the laboratory. In case identification proves impossible due to lack of certain parts at the time of survey, additional visits to the site are made in a more appropriate season. Voucher material is retained, dried or in a preserving liquid, of difficult or dubious specimens. Angiosperms, charophytes, mosses and liverworts are identified to species level. Some non-charophyte algae are considered at genus level (*Enteromorpha*, *Hydrodyction*); cyanobacterial films and filamentous algae are recognized by general aspect, only.

Reporting
No procedures have been established, yet.

Assessment

Data requirements
Attribution of the site to a water type. Map of water-surface segments and shoreline stretches; relative weighths for segments and stretches. Macrophyte survey data for individual segments and strectches.

Calculation
The index for **type-specific species composition** (TS) indicates the relative abundance-weighted agreement between observed species composition and that expected for the water type. For each water type, a list of species which may occur in the type in the absence of human disturbance was compiled (0: species does not occur naturally; 1: occurrence possible in natural conditions). Invasive neophytes are never considered to be type specific (see Annex 1). For each segment and stretch the index is given by:

$$TS = \frac{\sum_{i=1}^{n}\left(Ab_i \cdot ts_i\right)}{\sum_{i=1}^{n} Ab_i}$$

Ab_i : abundance of taxon i;
ts_i : type-specificity value of taxon i (0 or 1);
n : number of observed taxa included in the standard list;
TS : index for type specificity.

The EQR is derived for riparian and water vegetation, separately, by weighing the scores of stretches or segments by their relative importance, giving a set of two EQRs: TS_o and TS_w.

The index for the **abundance of disturbance indicators** (V) gives the relative abundance-weighted occurrence of pollution (sewage, eutrophication, acidification) indicating species. Disturbance indicators are listed for each water type, separately (0: no marked indication; 1: deteriorating quality with increasing abundance); only the most reliable disturbance indicators are included. Type-specific taxa can still be disturbance indicators. For each segment and stretch the index is given by:

$$V = 1 - \frac{\sum_{i=1}^{n}\left(Ab_i \cdot v_i\right)}{\sum_{i=1}^{n} Ab_i}$$

Ab_i : abundance of taxon i;
v_i : perturbation score of taxon i (0 or 1);
n : number of observed taxa included in the standard list;
V : index for disturbance.

The index is derived for riparian and water vegetation, separately, by weighing the scores of stretches or segments by their relative importance, yielding two EQRs: V_o and V_w.

For each water type, an expected spectrum and diversity of macrophyte **growth forms** (GV) is described for the aquatic vegetation (= only vegetation in the water at the time of surveying, not the riparian vegetation; Table 2). Only the presence of growth forms is taken into account, not their abundance. For each water type (*cf.* Jochems *et al*. 2002), the number and expected combination of growth forms is scored according to Table 3. Presence of cyanobacterial films is scored negatively. The scores are summed and the number of species indicating a more exceptional ecological quality (as indicated in Annex 1) is added. The resulting sum is used to calculate the ratio to the 'basic sum' for the water type. A list is provided of the possible growth forms for all taxa considered in the assessment, but their actual growth form should be noted in the field.

Table 3. Scoring of growth forms for selected water types.

BE-FL type	Ami-om mixed, alkaline, moderate ionic concentration, lower background nutrients	Ami-e mixed, alkaline, moderate ionic concentration, higher background nutrients	Ai mixed, alkaline, higher ionic concentration	Aw-om stratified, lower background nutrients	Aw-e stratified, higher background nutrients
GIG type	LCB-2			LCB-1	
lemnid	1	1	1	1	1
large pleustophyte	1	1	1	-	-
submerse, non-rooting	1	1	1	-	1
charid	2	2	2	2	2
magnopotamid	1	1	1	2	2
other rooting caulescent hydrophtyte	1	1	1	1	1
nymphaeid	1	1	1	1	1
vallisnerid	-	-	-	-	-
isoetid	-	-	-	2	-
small and medium-sized riparian plant	1	1	1	1	1
large monocot	1	1	1	1	1
peat moss	-	-	-	1	-
BASIC SUM	10	10	10	12	10
cyanobacterial film	-1	-1	-1	-1	-1

(alkalinity < or > 2 meq L^{-1} can be used as a rough guideline to distinguish Ami from Ai types)

The fourth EQR considers submerged **vegetation development** (VO). From the abundance of submerged vegetation (cf. Table 2), a score is derived for each segment according to Table 4. A weighted average of these scores is calculated for the entire lake, which is then transformed using Table 5.

Table 4. Scoring of submerged vegetation abundance.

abundance	score
0	0
1	1
2	2
3	1

Table 5. Conversion of the weighted submerged vegetation abundance score to an EQR.

average score	EQR
1,6-2	0,8-1
1,2-<1,6	0,6-<0,8
0,8-<1,2	0,4-<0,6
0,4-<0,8	0,2-<0,4
0-<0,4	0-<0,2

The EQR scale is divided into five equal classes for all metrics (Table 6).

Table 6. EQR values in relation to classification.

class	EQR = minimum(TS_W, TS_o, V_o, V_w , GV, VO)
high	0.80 – 1
good	0.60 – <0.80
moderate	0.40 – <0.60
poor	0.20 – <0.40
bad	0 – <0.20

The **overall quality** (EQR) for a lake is given by the lowest scoring metric (‘one out – all out’ principle).

Example
Site descriptors:

- regional type: Ami-e (LCB-2), maximum depth 1.8 m;
- riparian zone: 2 stretches; A 750 m, B 250 m;
- aquatic zone: 2 segments; segment A 46875 m^2, segment B 15625 m^2
- vegetation data : see Table 7.

Table 7. Example data for an imaginary Ami-e site.

	riparian zone		aquatic zone	
	stretch A	stretch B	segment A	segment B
relative importance	75 %	25 %	75 %	25 %
presence cyanobacterial films	not rel.	not rel.	-	+
abundance submerged vegetation < 2 m (0-3)	not rel.	not rel.	2	1
Alisma plantago-aquatica	-	1	1	-
Phragmites australis	2	5	1	-
Urtica dioica	3	2	-	-
Ceratophyllum demersum	-	-	5	
Lemna minor	-	-	-	1
Nitella mucronata	-	-	1	-
Potamogeton acutifolius	-	-	-	1
P. pusillus	-	-	-	2

Metric 1 - TS: *Alisma plantago-aquatica*, *Phragmites australis*, *Ceratophyllum demersum*, *Lemna minor*, *Nitella mucronata*, *Potamogeton acutifolius* and *P. pusillus* are type specific (cf. Annex 1).

- TS_o: 0.75(2/5) + 0.25(6/8) = 0.3 + 0.1875 = 0.4875 (moderate)
- TS_w: 0.75(8/8) + 0.25(4/4) = 0.75 + 0.25 = 1 (high)

Metric 2 - V: *Urtica dioica*, *Ceratophyllum demersum* and *Lemna minor* are disturbance indicators (cf. Annex 1, S).

- V_o = 1 - (0.75(3/5) + 0.25(2/8)) = 1 - (0.5625 + 0.0625) = 0.375 (poor)
- V_w = 1- (0.75(5/8) + 0.25(1/4)) = 1 - (0.8333 + 0.0625) = 0.1042 (bad)

Metric 3 - GV: cf. Table 3.

- present are: lemnid (*Lemna*), submerse non-rooting (*Ceratophyllum*), charid (*Nitella*), other rooting caulescent hydrophyte (both *Potamogeton* spp.), small-medium sized riparian (*Alisma*), large monocotyledonous (*Phragmites*): sum = 7;
- one species indicates exceptional quality (*Potamogeton acutifolius*; Annex 1, B): sum = 7 + 1 = 8;
- cyanobacterial films are present: sum = 8 – 1 = 7

- basic sum for Ami-e is 10 (Table 3): GV = 7/10 = 0.70 (good)

Metric 4 - VO:
- score: (0.75 x 2) + (0.25 x 1) = 1.75
- VO = 1.75/2 = 0.875 (high)

Final EQR: MIN(0.4875, 1, 0.375, 0.1042, 0.70, 0.875) = 0.1042 (bad; due to V_w)

Reference, H/G, G/M
Contemporary references are absent or extremely scarce for all types prohibiting a spatial reference approach. The assessment is therefore based on vegetation attributes which can be estimated from the remaining sites presenting higher quality, historical records, and information on the behaviour of species and the structural response of aquatic vegetations in relation to pressures, making as few assumptions as possible. This information is integrated by expert judgement. Expectations for growth form diversity are based mainly on expert judgement, envisaging a functionally 'complete' system with undisturbed vegetation succession (incl. terrestrialization) for each water type. Development of submerged vegetation is added as a robust semi-quantitative assessment of the expected response in productivity to eutrophication, mainly, with both reduced and superfluous abundance leading to a lower status assessment. Boundary values are set by expert judgement with the requirement that good status can only be attained if taxa which are not specific for the water type or indicate disturbance remain notably less abundant relative to type-specific and non-disturbance species.

Correlation to pressures
The EQR shows a highly significant negative correlation to measured pressure-related variables, such as chlorophyl concentration and TP. Indication of high or good status is unlikely to occur if the values of such variables are markedly elevated (e.g. Figure 1). However, the degree of submerged vegetation development (VO) is an essential element of the EQR. If this metric is not taken into account, such relations deteriorate particularly in the range from bad to moderate. The EQR is not specifically or exclusively aimed at detecting eutrophication, but will also reflect the impact of other kinds of pollution, exclusion of native by invasive species, functional impairment and habitat loss by other biological pressures.

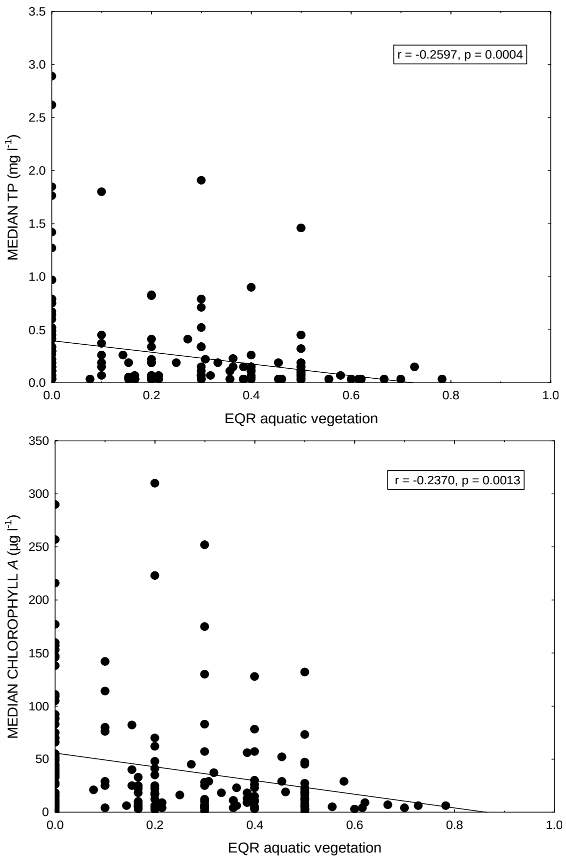


Figure 1. EQR values for the aquatic vegetation in relation to TP and chlorophyll concentration in alkaline BE-FL water bodies (G/M at EQR 0.6).

Differences between national data and assessment vs. GIG data and assessment

Completeness of method
Riparian vegetation can not be considered for the GIG data, as most MSs did not provide such data. All helophytes were removed from the relevées of the water vegetation and some additional taxa were left unconsidered in the final data as well (e.g. *Pillularia*, *Nitella gracilis*, *Hydrodyction*, *Enteromorpha*, mosses). These alterations may possibly influence the outcome of the BE-FL assessment, which considers the aquatic vegetation more completely. Presence of cyanobacterial films, and for some MSs abundance of filamentous algae are unknown, also. The lack of data on 'segment level' and the conversion to a less precise abundance scale (Table 7) further constrain the assessment result. Development of submerged vegetation can not be inferred reliably from the GIG data and is not included in the reported results. The growth forms 'medium-sized riparian plant', and 'large monocotyledonous riparian plant' are assumed to be present in the aquatic vegetation of all the lakes.

Data transformation to GIG data base
The BE-FL abundance data are scaled-up to the entire water surface and converted according to Table 7.

Table 7. Conversion of BE-FL abundance scale to GIG abundance scale.

Original abundance	Abundance GIG
1-2	1
3	2
4-5	3

Assessment transformation to the GIG data base
VO can not be calculated from the available data, so the BE-FL GIG assessment only considers the metrics TS_W, V_w and GV. Lakes where both the summed abundance of submerged plants (thus excl. floating-leaved plants) and the abundance of individual submerged taxa are extremely low are excluded from the comparison because of the very high risk for a too positive classification. This selection can produce a bias towards higher values in the distribution of classification results, influencing the comparison by 'method 3'. The effect of leaving out VO can easily result in an overestimation of the EQR. With survey data from 221 BE-FL sites, the EQR values dropped by including an overall estimate of VO on average with 0.03 units for sites originally classified as bad status, with 0.09 units (almost ½ of a class) for sites of poor and moderate status, 0.19 units (almost 1 class) for 4 sites of good status and 0.33 units (> 1.5 class) for one site considered to be of high status by the other EQRs. The number of sites in each status class with both classification methods is shown in Figure 2. In this case, changes in the classification at class level are most marked for the categories good, poor and bad.

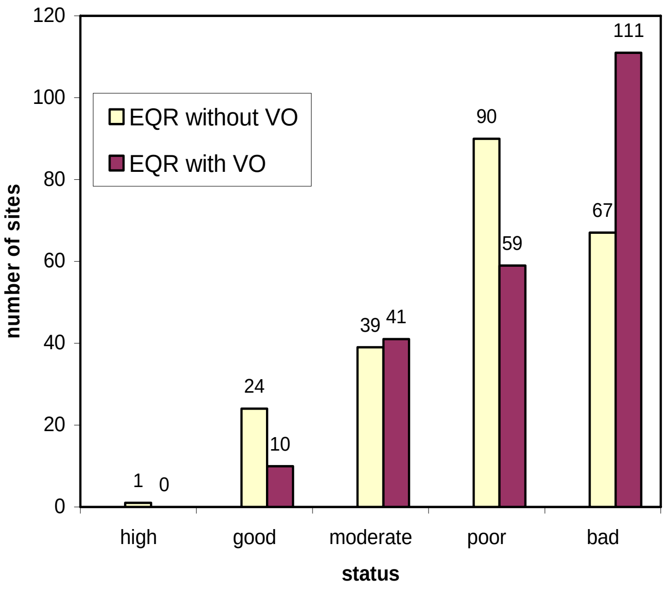


Figure 2. The effect of including VO in the classification of BE-FL sites.
At the level of GIG lake types, the difference amounts, on average, to 0.11 ± 0.20 EQR units for LCB-1 sites (N=21) and to 0.10 ± 0.14 units for LCB-2 (123 sites), or a decrease with about 1/2 of a class interval.

If the summed abundance of taxa that are not indigenous in BE-FL, nor present there as neophytes, exceeds 10 % of the total abundance no class or EQR is calculated. In case their summed abundance is less than 10

%, such taxa are excluded from the calculation of TS_W and V_w, but included for GV. Similary, some taxa can not be accounted for because of an insufficient degree of taxonomic discrimination (e.g. Charophyta, where at least an indication of the genus is required). Taxa for which only the growth form is considered by the BE-FL assessment of GIG sites are:

- for LCB-1: *Callitriche hermaphroditica*, *Chara filiformis*, *C. intermedia*, *C. rudis*, *C. strigosa*, *C. tomentosa*, Charophyta, *Hydrilla verticillata*, *Isoetes lacustris*, *Potamogeton rutilus*, *P.* x *nitens*, *P.* x *suecicus*, *Sagittaria sagittifolia* x *natans*, *Utricularia*, *Nuphar* x *spenneriana*;
- for LCB-2: *Callitriche hermaphroditica*, *Chara intermedia, C. rudis*, *C. tomentosa*, Charophyta, *Isoetes lacustris*, *Najas flexilis*, *N. tenuissima*, *Potamogeton rutilus*, *P. vaginatus*, *P.* x *nitens*, P. x sparganiifolius, *Ranunculus confervoides*, *Sagittaria sagittifolia* x *natans*, *Nuphar* x *spenneriana*, *Nymphaea candida* x *tetragona*, *Utricularia*, *Trapa natans*;
- for LCB-3 *Callitriche hermaphroditica*, Charophyta, *Isoetes lacustris*, *Potamogeton rutilus*, *P.* x *nitens*, *Sparganium gramineum*, *S. angustifolium* x *gramineum*, *Utricularia*, *Nuphar* x *spenneriana*.

To select between Aw-om and Aw-e as the 'most appropriate' regional type for non-BE-FL LCB-1 lakes, the following criteria are applied: Aw-om if EC < 300 µS; cm^{-1} and/or presence of *Eleocharis acicularis*, *Elatine* spp., *Littorella*, *Potamogeton alpinus*, *P. gramineus*, *Myriophyllum alterniflorum*, *Chara hispida*, *Utricularia minor* or *U. intermedia*; to choose between Ami-om and Ami-e for LCB-2: Ami-om in case of presence of *Chara aspera*, *C. hispida*, *C. tomentosa*, *Potamogeton alpinus*, *P. gramineus* or *Utricularia minor*[1]. Eutrophied sites where such species have been lost can not be discerned from naturally more eutrophic lakes on this basis, which can lead to a too positive classification. With HU sites exluded, 35 % of the LCB-1 sites and 20.5 % of the LCB-2 sites are attributed to Aw-om and Ami-om, respectively. The assessment is more lenient with regard to trophic background conditions for the types Aw-e and Ami-e to which most of the lakes are referred to. Typological misclasifications will affect the results.

Annex 1. Standard macrophyte list for WFD lake assessment in Belgium-Flanders (version February 2007).

1 – type specific, B – indicates exceptional ecological quality (allows upgrading of growth-form metric), S – disturbance indicator, N – neophyte, N/Z – invasive neophyte.

intercalibration type						**LCB-2**			**LCB-1**				
regional type	**Zs**	**Zm**	**Czb**	**CFe**	**Cb**	**Ami-om**	**Ami-e**	**Ai**	**Aw-om**	**Aw-e**	**Ad**	**Bzl**	**N/Z**
Acorus calamus							1	1		1			N
Agrostis canina	S	1S	1	1	1				1				
Agrostis gigantea					1		1	1		1	1	1	
Agrostis stolonifera				1	1	1	1	1	1	1	1	1	
Alisma gramineum								1B		1B	1B	1B	
Alisma lanceolatum							1	1		1		1	
Alisma plantago-aquatica							1	1		1	1	1	
Alnus glutinosa				1	1	1	1	1	1	1			
Alopecurus aequalis							1	1					
Alopecurus bulbosus												1	
Alopecurus geniculatus							1	1					
Anagallis tenella					1B	1B					1B		
Angelica archangelica							1	1		1		1	N
Angelica sylvestris							1	1		1			
Apium graveolens												1	
Apium inundatum		1B	1B	1B	1B						1B		
Apium nodiflorum								1		1	1	1	
Apium repens								1B			1B	1	
Aster tripolium												1	
Azolla filiculoides	S	S	S	S	S	S	S	1S	S	S	S	1S	N
Baldellia ranunculoides		1B	1B		1B				1B		1B		
Baldellia repens		1B	1B		1B				1B				
Berula erecta							1	1		1	1		
Bidens cernua	S	S	S	1S	1S	S	1S	1	1	1			
Bidens connata					1		1	1	1	1			N
Bidens frondosa	S	S	S	S	S	S	1S	1	1	1	S		N
Bidens tripartita	S	S	S	S	1S	S	1S	1		1	S		
Butomus umbellatus								1		1		1	
Cabomba caroliniana					1		1						N
Calamagrostis canescens					1	1	1	1	1	1			
Calla palustris			1	1B	1		1						
Callitriche brutia				1	1								
Callitriche hamulata			1	1	1		1		1		1		
Callitriche obtusangula	S	S	S	S	S	S	1	1		1		1	

[1] The result was forwarded for correction to the experts of EE, DE, LV, NL, PL and UK. Only EE responded, disagreeing with the proposed attribution but no suggestions for improvement were received.

Callitriche palustris					1		1	1			1		
Callitriche platycarpa			1	1	1	1	1	1			1		
Callitriche stagnalis			1	1	1		1	1			1	1	
Callitriche truncata							1	1				1	
Caltha palustris				1	1	1	1	1B					
Calystegia sepium							1	1		1		1	
Cardamine amara							1	1					
Cardamine flexuosa							1	1		1	1		
Cardamine pratensis			1	1	1	1	1	1	1	1			
Carex acuta							1	1		1	1	1	
Carex acutiformis					1	1	1	1		1	1	1	
Carex brizoides				1	1								
Carex canescens	1	1	1	1									
Carex demissa		1	1	1	1								
Carex diandra				1B	1B	1B							
Carex dioica					1B	1B							
Carex disticha							1	1		1	1	1	
Carex divisa												1	
Carex echinata		1	1	1	1								
Carex elata		1	1	1	1		1						
Carex elongata			1	1	1		1						
Carex flava				1B	1B	1B	1B						
Carex hostiana				1B	1B	1B	1B						
Carex lasiocarpa	1B	1B	1B	1B	1B	1B							
Carex lepidocarpa						1B							
Carex limosa	1B	1B											
Carex nigra		1	1	1	1	1					1		
Carex panicea		1	1	1	1	1							
intercalibration type							**LCB-2**			**LCB-1**			
regional type	**Zs**	**Zm**	**Czb**	**CFe**	**Cb**	**Ami-om**	**Ami-e**	**Ai**	**Aw-om**	**Aw-e**	**Ad**	**Bzl**	**N/Z**
Carex paniculata							1	1		1	1	1	
Carex pendula						1	1						
Carex pseudocyperus							1	1		1	1		
Carex remota				1	1	1	1	1	1	1			
Carex riparia							1	1			1	1	
Carex rostrata	1	1	1	1	1	1			1				
Carex trinervis											1B		
Carex vesicaria					1		1						
Carex viridula		1	1	1	1				1				
Carex viridula var. *pulchella*		1B									1		
Carum verticillatum				1	1								
Catabrosa aquatica	S	S	S	S	S	S	S	1S	S	S	S	1	
Centaurium littorale											1	1	
Centaurium pulchellum								1		1	1	1	
Ceratophyllum demersum	S	S	S	S	1S	S	1S	1S	S	1S	S	1	
Ceratophyllum submersum	S	S	S	S	S	S	S	1S	S	S	S	1	
Cetunculus minimus			1B		1B				1B		1B		
Chara aculeolata						1B					1B		
Chara aspera						1B	1B	1B	1B	1B	1B	1	
Chara baltica											1B	1	
Chara braunii			1		1								
Chara canescens											1B	1	
Chara connivens								1B			1B	1	
Chara contraria						1	1	1	1	1	1	1	
Chara contraria var. *hispidula*						1	1	1	1	1	1	1	
Chara fragifera						1B							
Chara globularis					1	1	1	1	1	1	1	1	
Chara hispida						1B	1B	1B	1B	1B	1B	1B	
Chara pedunculata												1	
Chara sp.			1		1	1	1	1	1	1	1	1	
Chara virgata					1	1	1	1	1	1	1	1	
Chara vulgaris						1	1	1		1	1	1	
Chara vulgaris var. *crassicaulis*						1B	1B	1B			1B		
Chara vulgaris var. longibracteata						1	1	1		1	1	1	
Chara vulgaris var. *papillata*						1	1	1			1	1	
Cicendia filiformis		1B	1B		1B	1B			1B				
Cicuta virosa	S	S	S	1S	1S	S	1	1		1			
Circaea lutetiana							1						
Cirsium dissectum			1B		1B	1B							
Cirsium oleraceum							1	1					
Cirsium palustre				1	1		1	1		1	1		
Cladium mariscus					1	1	1B	1B		1B	1B	1	
Cochlearia officinalis												1	
Comarum palustre		1	1	1	1	1			1		1		
Crassula helmsii													N/Z

Crepis paludosa						1	1						
Cyperus fuscus								1		1			
Dactylorhiza fistulosa				1	1	1	1	1			1		
Dactylorhiza praetermissa				1	1	1	1	1		1	1		
Deschampsia cespitosa					1		1						
Deschampsia setacea		1B	1B										
Drepanocladus aduncus							1	1		1	1		
Drepanocladus exannulatus		1											
Drepanocladus fluitans	1S	1S											
Drosera intermedia	1	1							1				
Drosera rotundifolia	1	1											
Egeria densa							1	1		1	1	1	N
Elatine hexandra		1	1		1		1		1B				
Elatine hydropiper					1		1						
Elatine triandra					1B		1B						
Eleocharis acicularis		1	1		1				1		1		
Eleocharis multicaulis	1	1	1						1B				
Eleocharis ovata					1B		1B						
Eleocharis palustris		1	1	1	1	1	1	1	1	1	1	1	
Eleocharis quinqueflora						1B					1B		
Eleocharis uniglumis								1		1	1	1	
intercalibration type						**LCB-2**			**LCB-1**				
regional type	**Zs**	**Zm**	**Czb**	**CFe**	**Cb**	**Ami-om**	**Ami-e**	**Ai**	**Aw-om**	**Aw-e**	**Ad**	**Bzl**	**N/Z**
Elodea canadensis	S	S	S	S	1S	1S	1	1	S	1		1	N
Elodea nuttallii	S	S	S	S	S	S			S				N/Z
Enteromorpha intestinalis	S	S	S	S	S	S	S	1S	S	1S	S	1	
Epilobium hirsutum	S	S	S	S	S	S	1S	1S	S	1S	S	1S	
Epilobium obscurum				1	1		1						
Epilobium palustre			1	1	1				1		1	1	
Epilobium roseum							1	1		1			
Epilobium tetragonum							1	1		1	1	1	
Equisetum fluviatile				1	1	1	1	1B	1	1B	1		
Equisetum palustre				1	1	1	1	1	1	1	1		
Equisetum telmateia							1						
Eriophorum gracile		1B	1B	1B	1B								
Eriophorum latifolium						1B							
Eriophorum polystachion	1	1	1										
Festuca arundinacea							1	1	1	1	1		
filamentous algae	S	S	S	S	S	S	S	S	S	S	S	S	
Filipendula ulmaria							1						
Fontinalis antipyretica						1	1	1	1	1	1		
Fritillaria meleagris							1B	1B					
Galium palustre		1	1	1	1	1	1	1	1	1	1	1	
Galium uliginosum		1	1	1	1								
Glaux maritima												1	
Glyceria declinata				1	1		1	1	1	1			
Glyceria fluitans	S	S	S	1S	1S	S	1S	1		1			
Glyceria maxima	S	S	S	S	S	S	1S	1S	S	1	S	1	
Glyceria notata								1		1		1	
Gnaphalium luteoalbum								1		1	1	1	
Gnaphalium uliginosum							1		1	1	1		
Gratiola officinalis							1B	1B					
Groenlandia densa								1B		1B	1		
Hammarbya paludosa		1B	1B										
Hippuris vulgaris								1		1B	1	1	
Hottonia palustris			1	1	1	1	1	1B		1	1		
Hydrocharis morsus-ranae			1	1	1	1	1	1			1		
Hydrocotyle ranunculoides	S	S	S	S	S	S	S	S	S	S	S	S	N/Z
Hydrocotyle vulgaris	1S	1	1	1	1		1		1	1	1		
Hydrodiction reticulatum	S	S	S	S	S	S	1S	1 S	S	S	S	S	
Hypericum elodes		1	1	1	1				1B				
Hypericum tetrapterum					1	1	1		1		1		
Illecebrum verticillatum			1		1								
Iris pseudacorus				1	1		1	1		1	1	1	
Isoetes echinospora		1B	1B		1B				1B				
Juncus acutiflorus					1				1				
Juncus alpinoarticulatus						1B							
Juncus ambiguus								1		1	1	1	
Juncus anceps											1		
Juncus articulatus				1	1	1	1		1	1	1	1	
Juncus bufonius			1	1	1		1	1	1	1	1	1	
Juncus bulbosus	1	1	1	1	1				1				
Juncus canadensis	S												N/Z
Juncus compressus							1	1		1		1	
Juncus conglomeratus		1	1	1	1				1				
Juncus effusus	S	1S	1	1	1		1		1	1			

Juncus filiformis		1B	1B	1B	1B								
Juncus gerardii												1	
Juncus inflexus							1	1		1	1	1	
Juncus squarrosus	1	1	1										
Juncus subnodulosus						1	1	1		1	1	1	
Juncus tenuis							1		1	1	1		N
Lagarosiphon major	S	S	S	S	S	S			S	1	1		N/Z
Leersia oryzoides							1	1		1			
Lemna gibba								1				1	
Lemna minor	S	S	1S	1S	1S	1S	1S	1S	1S	1S	1S	1S	
Lemna minuta	S	S	S	S	S	S	S	S	S	S	S	S	N/Z
Lemna trisulca				1	1		1	1			1	1	
Leucojum aestivum							1						
Limonium vulgare												1	
Limosella aquatica		1	1		1		1B	1B		1B	1B	1	
intercalibration type							**LCB-2**		**LCB-1**				
regional type	**Zs**	**Zm**	**Czb**	**CFe**	**Cb**	**Ami-om**	**Ami-e**	**Ai**	**Aw-om**	**Aw-e**	**Ad**	**Bzl**	**N/Z**
Lindernia dubia					1		1						N
Lindernia procumbens					1		1						N
Liparis loeselii						1B					1B		
Littorella uniflora		1	1		1				1B		1B		
Lobelia dortmanna	1B	1B	1B		1B								
Lotus pedunculatus			1	1	1		1	1	1	1			
Ludwigia grandiflora													N/Z
Ludwigia palustris			1	1	1								
Ludwigia peploides													N/Z
Luronium natans		1B	1B	1B	1B				1B				
Lycopodiella inundata		1B	1B						1B				
Lycopus europaeus	S	S	1	1	1	1	1	1	1	1	1	1	
Lysimachia nummularia					1	1	1	1		1	1		
Lysimachia thyrsiflora				1	1	1	1B		1	1			
Lysimachia vulgaris			1	1	1	1	1	1	1		1		
Lythrum portula		1	1		1				1		1		
Lythrum salicaria	S	S	S	S	S	S	1S	1S	S	1S	1S		
Mentha aquatica			1	1	1		1	1	1	1	1	1	
Menyanthes trifoliata	1B	1B	1B	1B	1B	1B					1B		
Mimulus guttatus							1						N
Molinia caerulea	1S	1	1	1	1				1				
Myosotis cespitosa							1	1		1	1		
Myosotis scorpioides							1	1		1		1	
Myosoton aquaticum							1	1		1			
Myrica gale	1	1	1										
Myriophyllum alterniflorum		1B	1B	1B	1B				1B				
Myriophyllum aquaticum													N/Z
Myriophyllum spicatum							1	1		1	1	1	
Myriophyllum verticillatum			1B	1B	1B	1B	1B	1B	1B	1B	1B		
Najas marina								1				1	
Najas minor							1B	1B					
Narthecium ossifragum	1B	1B											
Nasturtium microphyllum				1	1		1	1		1		1	
Nasturtium officinale							1	1		1	1	1	
Nitella capillaris				1	1B	1B							
Nitella confervacea				1	1	1							
Nitella flexilis en flexilis/opaca		1	1		1	1	1B		1				
Nitella gracilis		1B	1B		1B				1B				
Nitella mucronata			1		1		1			1	1		
Nitella mucronata var. *gracilima*							1	1		1			
Nitella opaca			1		1	1	1B		1				
Nitella sp.		1	1	1	1	1	1	1	1	1	1		
Nitella syncarpa					1B		1B						
Nitella tenuissima						1B							
Nitella translucens		1	1	1	1		1B		1		1		
Nitellopsis obtusa						1B	1B	1B	1B	1B		1	
Nuphar lutea							1	1		1			
Nuphar pumila		1B	1B	1B	1B								
Nymphaea alba				1	1	1	1	1		1			
Nymphaea alba var. *occidentalis*				1	1	1							
Nymphaea candida			1	1B	1B								
Nymphaea div. spec.			1	1	1	1	1	1	1	1	1	1	N
Nymphoides peltata							1	1		1			
Oenanthe aquatica							1	1		1	1	1	
Oenanthe crocata											1B		
Oenanthe fistulosa							1	1		1	1	1	
Oenanthe lachenalii												1	

Osmunda regalis				1	1	1	1						
Parnassia palustris						1					1	1	
Pedicularis palustris			1B		1B	1B					1B		
Petasites hybridus							1	1					
Peucedanum palustre		1	1	1	1				1				
Phalaris arundinacea							1	1		1		1	
Phragmites australis			1	1	1	1	1	1	1	1	1	1	
Pilularia globulifera		1	1	1	1				1B				
intercalibration type							**LCB-2**		**LCB-1**				
regional type	**Zs**	**Zm**	**Czb**	**CFe**	**Cb**	**Ami-om**	**Ami-e**	**Ai**	**Aw-om**	**Aw-e**	**Ad**	**Bzl**	**N/Z**
Pinguicula vulgaris		1B	1B										
Polygonum amphibium	S	S	S	S	S	S	1	1	S	1	1	1	
Polygonum hydropiper	S	S	S	S	S	S	1	1	S	1			
Polygonum minus			1	1	1		1						
Polygonum mite							1	1		1			
Potamogeton acutifolius					1B	1B	1B	1B		1B			
Potamogeton alpinus				1B	1B	1B	1B		1B				
Potamogeton berchtoldii			1		1		1	1	1				
Potamogeton coloratus						1B					1B	1	
Potamogeton compressus					1		1B						
Potamogeton crispus							1	1		1	1	1	
Potamogeton filiformis											1		
Potamogeton friesii					1		1	1		1		1	
Potamogeton gramineus		1B	1B		1B				1B		1B		
Potamogeton lucens						1	1	1		1			
Potamogeton natans		1	1	1	1	1	1	1B	1	1	1		
Potamogeton nodosus										1B			
Potamogeton obtusifolius		1	1	1	1	1	1B		1			1	
Potamogeton pectinatus	S	S	S	S	S	S	1S	1S	S	1	1	1	
Potamogeton perfoliatus						1	1	1B		1		1	
Potamogeton polygonifolius		1	1	1	1				1B				
Potamogeton praelongus					1B	1B	1B		1B	1B			
Potamogeton pusillus					1		1	1		1	1	1	
Potamogeton trichoides						1	1	1		1	1	1	
Potamogeton zizii					1B		1B						
Pulicaria dysenterica							1	1		1	1	1	
Pulicaria vulgaris							1	1		1			
Radiola linoides		1B	1B		1B	1B			1B				
Ranunculus aquatilis							1	1	1	1	1	1	
Ranunculus baudotii											1	1	
Ranunculus circinatus							1	1		1	1	1	
Ranunculus flammula		1	1	1	1		1		1				
Ranunculus hederaceus					1B		1B						
Ranunculus lingua							1B	1B		1B	1		
Ranunculus ololeucos		1B	1B										
Ranunculus omiophyllus					1B								
Ranunculus peltatus		1	1		1		1		1		1		
Ranunculus sceleratus	S	S	S	S	S	S	S	1S	S	1S	S	1	
Ranunculus trichophyllus							1	1		1	1	1	
Ranunculus tripartitus		1B	1B										
Rhynchospora alba	1B	1											
Rhynchospora fusca	1	1											
Riccia fluitans	S	S	1S	1S	1S	1S	1	1					
Ricciocarpos natans								1B					
Rorippa amphibia							1	1		1			
Rorippa palustris	S	S	S	S	S	S	1	1	S	1	S		
Rorippa sylvestris	S	S	S	S	S	S	1	1	S	1	S		
Rumex aquaticus							1	1		1			
Rumex conglomeratus							1	1		1			
Rumex hydrolapathum	S	S	S	S	S	S	1	1	S	1	1S	1	
Rumex maritimus	S	S	S	S	S	S	S	1S	S	S	S	1	
Rumex palustris	S	S	S	S	S	S		1	S	1	S	1	
Rumex sanguineus	S	S	S	S	S	S	1	1	S	1	S		
Ruppia cirrhosa											1B	1	
Ruppia maritima											1B	1	
Sagina nodosa						1B					1	1	
Sagittaria sagittifolia							1	1		1			
Salix alba						1	1	1	1	1	1	1	
Salix aurita		1	1	1	1								
Salix cinerea			1	1	1	1	1		1		1		
Salix fragilis					1		1	1	1	1			
Salix pentandra				1	1		1						N
Salix purpurea							1	1		1	1		
Salix triandra							1	1		1			
Salix viminalis							1	1		1			
Salvinia natans													N

Samolus valerandi						1	1	1		1	1	1	
Scheuchzeria palustris	1B	1B											
intercalibration type							**LCB-2**		**LCB-1**				
regional type	**Zs**	**Zm**	**Czb**	**CFe**	**Cb**	**Ami-om**	**Ami-e**	**Ai**	**Aw-om**	**Aw-e**	**Ad**	**Bzl**	**N/Z**
Schoenus nigricans						1B					1B		
Scirpus fluitans	1	1	1	1	1				1				
Scirpus lacustris					1	1	1	1		1	1		
Scirpus maritimus								1			1	1	
Scirpus pungens												1	
Scirpus setaceus					1				1		1		
Scirpus sylvaticus							1	1		1			
Scirpus tabernaemontani								1		1	1	1	
Scirpus triqueter							1	1					
Scrophularia auriculata							1	1		1			
Scrophularia umbrosa							1	1		1			
Scutellaria galericulata			1	1	1		1	1		1	1		
Scutellaria minor			1	1	1	1							
Senecio aquaticus					1		1						
Senecio congestus								1		1		1	
Senecio paludosus							1	1		1			
Senecio sarracenicus													N
Sium latifolium						1	1	1		1		1	
Solanum dulcamara	S	S	S	S	S	S	1	1	S	1	1	1	
Sparganium angustifolium	1B	1B	1B										
Sparganium emersum	S	S	S	1	1	1	1	1	S	1	S		
Sparganium erectum	S	S	S	1	1		1	1	S	1	S	1	
Sparganium natans		1B	1B	1B	1B								
Sphagnum compactum	1	1											
Sphagnum cuspidatum	1	1											
Sphagnum denticulatum	1	1	1						1				
Sphagnum fallax	1	1											
Sphagnum fimbriatum		1	1										
Sphagnum flexuosum		1	1										
Sphagnum majus	1	1											
Sphagnum molle	1	1											
Sphagnum palustre		1	1						1				
Sphagnum papillosum	1	1											
Sphagnum squarrosum		1	1						1				
Sphagnum tenellum	1	1											
Sphagnum terres		1	1						1				
Spiranthes aestivalis						1B					1B		
Spirodela polyrhiza	S	S	S	S	S	S	1S	1S	S	1S	S	1	
Stachys palustris							1	1		1			
Stellaria palustris					1		1	1		1	1		
Stratiotes aloides					1	1	1B	1B				1	
Subularia aquatica		1B	1B										
Symphytum officinale							1	1		1			
Teucrium scordium							1B	1B			1B		
Thalictrum flavum							1	1		1			
Thelypteris palustris				1B	1B		1B	1B			1B	1	
Tolypella glomerata												1	
Tolypella intricata							1B	1B			1B		
Tolypella prolifera								1B			1B	1	
Trifolium fragiferum								1		1		1	
Triglochin maritima												1	
Triglochin palustris					1	1	1	1			1	1	
Typha angustifolia	S	S	S	S	S	S	1	1	S	1		1	
Typha latifolia	S	S	S	S	1S	S	1	1	S	1		1	
Urtica dioica	S	S	S	S	S	S	S	S	S	S	S	S	
Utricularia australis		1	1	1	1	1	1B				1		
Utricularia intermedia		1B	1B	1B									
Utricularia minor	1B	1B	1B			1B							
Utricularia ochroleuca		1B	1B										
Utricularia vulgaris			1	1	1	1	1	1B			1		
Vaccinium oxycoccus	1B	1B											
Valeriana dioica				1	1		1						
Valeriana repens							1	1		1	1		
Vaucheria spp.								1			1	1	
Veronica anagallis-aquatica							1	1		1	1	1	
Veronica anagallis-aquatica subsp. *aquatica*								1		1	1	1	
Veronica beccabunga							1	1			1		
intercalibration type							**LCB-2**		**LCB-1**				
regional type	**Zs**	**Zm**	**Czb**	**CFe**	**Cb**	**Ami-om**	**Ami-e**	**Ai**	**Aw-om**	**Aw-e**	**Ad**	**Bzl**	**N/Z**
Veronica longifolia							1	1		1			N
Veronica scutellata			1	1	1		1	1					

Viburnum opulus							1	1					
Viola palustris		1	1										
Wahlenbergia hederacea			1B										
Wolffia arrhiza	S	S	S	S	S	S	1S	1S	S				
Zannichellia palustris	S	S	S	S	S	S	1S	1S	S	1S	1S	1	
Zannichellia palustris subsp. *pedicellata*	S	S	S	S	S	S	S	1S	S	1S	1S	1	

Case UK – LEAFPACS (Draft Version 6 June 2007)

Status: Proposed national method which it is expected will be accepted for use in UK during the summer of 2007. (Refers only to macrophyte components, not phytobenthos)

Which indicators are used?

Macrophyte taxonomic composition:
The taxonomic composition of hydrophytes (including angiosperms, hepaticae, charophytes and bryophytes) is normally assessed at species level although there are some exceptions. The hydrophytes are assigned to one of 18 functional groups defined by a range of morphological characteristics. A species list with associated index values and functional group categories is supplied in Appendix 1 at the end of this document.

Macrophyte abundance:
Abundance is expressed as percentage cover of the area of the lake that is colonised, rather than as a percentage of the whole lake area. Data from a set of discrete sampling units are combined, and converted into a valid measure of the cover of different species at a site scale. There are two basic sampling units, a shoreline survey and a boat transect. The shoreline method collects well-replicated samples from a (potentially) narrow marginal strip of the littoral zone, while the boat-based survey collects spatially un-replicated data between the water's edge and the depth of maximum colonisation (or the centre of the water body if colonisation extends across the lake).

In terms of assessing the macrophyte assemblage of the water body these two surveys yield different currencies of data. The shoreline survey data for each depth sampled is expressed as a percentage presence out of the 5 spot samples taken. These data can then be viewed as an intensively sampled shoreline end of the boat transect. However these data points cannot be regarded as equivalent to the spot samples collected along the boat transect because the shoreline area (between the waters edge and 0.75m depth) may have been over-sampled relative to the dispersion of the 10 points along the boat transect. If the density of sampling points in the two surveys is the same then the data points are given equal weighting. If on the other hand, the vegetated zone is highly compressed beyond the maximum depth considered by the shoreline survey, the shoreline data is weighted by a ratio of sites per metre on the boat transect to sites per metre on the shore transect.

Summary
The method uses 3 key aspects of the hydrophyte community to assess status. It has been designed to work along the full gradient of lake types found in the UK which range from low alkalinity, oligotrophic to very high alkalinity naturally eutrophic lakes. The assessment is based on the following characteristics of hydrophytes in response to nutrients:

Taxonomic indicators

1. Change in species composition of the community.
   Metric (a) - Score of nutrient affinity for each taxa (Lake Macrophyte Nutrient Index or LMNI) derived statistically from 4500 surveys.
2. A unimodal response of the taxonomic or functional diversity of hydrophytes (number of taxa or number of functional groups)
   Metric (b) - Number of functional groups. Species are assigned to one of 18 different functional groups. These groups are defined by physical form.
   Metric (c) - Number of taxa present.

Abundance indicators

3. Change in the abundance of hydrophytes and macro algae
   Metric (d) % cover of hydrophytes
   Metric (e) % cover of macro algae

The method is designed to identify the anthropogenic effects of nutrient enrichment from a natural nutrient gradient, by comparing each of the above observed characteristics with reference values, expressed as an EQR. Rather than making arbitrary divisions of this gradient through a typology, lake specific reference values are determined from a series of environmental predictors. These are derived from a model developed from a population of reference lakes.

EQRs for each of these metrics are combined (after adjustment to a common scale), using weighted averaging according to the following principles:

i) The primary indicator of status is provided by the EQR for the taxonomic composition. However aschanges in the taxonomic composition with nutrient enrichment are less pronounced in high alkalinity, naturally more fertile lakes, changes in diversity become progressively more important at this end of the alkalinity gradient.
ii) In all lake types a lower than expected diversity can decrease the final quality class, (by weighted averaging of the diversity and composition EQRs) if the diversity EQR indicates a worse class than the composition EQR.
iii) However, diversity is only allowed to increase the final classification (by a weighted averaging of the diversity and composition EQRs) if the diversity EQR indicates a better class than the composition EQR, in higher alkalinity lakes, by using a variable weighting factor which increases along a reference nutrient gradient.
iv) Where the % cover or the proportion of macro-algae indicate a worse class[2] than the taxonomic indicators (Cover or macro-algal EQRs are less than the overall taxonomic EQR) the final status is reduced by weighted averaging of the respective EQRs.

How are these indicators monitored?

Sampling strategy

Historically, a variety of survey methods have been employed in UK lakes, usually involving varying numbers of shore-based and/or boat-based transects. During 2003/04 a new standard method was developed which has been adopted, with minor variations, by all the UK environment and conservation agencies.
The approach is to subdivide a water body into discrete sampling units. Within each of these units surveys are undertaken of approx. 100m of shore, strandline and the shallowest part of the littoral zone (<0.75m). Deeper water habitats are surveyed based on a boat

[2] High cover is never allowed to improve status

transect running perpendicular from the shore to the depth of maximum colonisation (see 2.2.4), leaving the shore at the mid-point of the 100m shore transect.
Lakes are divided into the appropriate number of sub-areas, and within those areas representative sites are chosen using the expert knowledge of the surveyors. These are expected to include any sheltered bays and shallow areas. The number of survey sites will therefore be proportionate to the complexity of the morphology of the lake. As a general rule, for lakes <50ha in area, the survey is repeated at 4 locations, representative of all the main habitats present. At lakes >50ha in area up to 8 locations are surveyed.
The shoreline survey consists of a set of four samples at 0.25, 0.5, 0.75 and >0.75m water depths on each of 5 short transects perpendicular to the shoreline. These samples are taken in such a way that approximately $1m^2$ area of lake bed is examined at each depth. The 5 transects are evenly distributed along a 100m length of shore. The boat transect, a continuation of the central shore survey transect, consists of a set of 10 points, evenly spaced from the maximum depth of colonisation back to the shore. These are also taken in a manner that ensures approximately $1m^2$ area of lake bed is examined at each sample point. In addition a less quantitative survey of the strandline and area between current water level and the high water mark is undertaken.

A full description of the method (Common Standards Monitoring Guidance for Standing Waters has been published by the UK Joint Nature Conservation Committee, and is available on their web site (www.jncc.gov.uk).

species composition and growth form

When is monitored and with which frequency?

Surveys are conducted between July and early September to coincide with the greatest expected variety and density of lake macrophytes, many of which over-winter as seeds or vegetative propagules. A minimum of one survey in three years is recommended, each being undertaken at the same time within the survey season to compensate for the natural range of variability in macrophyte species.

Use of equipment

In most cases a wire-covered double headed rake connected to a rope is used for sampling plants. This supplies information about both species composition and % cover. Where possible, species composition and cover are also assessed by using a bathyscope or other underwater viewer.

Analysis of sample and level of determination

Species composition

Most plants are determined to species in the field, occasionally this identification is validated in the laboratory. Difficult groups may be referred to national experts for confirmation of identification, and voucher specimens are preserved for future reference.

way of reporting basic data

There is a standard set of survey sheets to be completed for each site. The information from these will initially be recorded on standardised MS Excel spreadsheets for further processing. The UK environment agencies will eventually hold the data in their own dedicated archive databases.

Assessment

The analysis is based on a Lake Macrophyte Nutrient Index (LMNI) which assigns values to species of submerged or floating leafed macrophytes. These values are derived by reciprocal averaging and are based on an extensive dataset consisting of most of the existing recorded data for UK lake surveys (4500 surveys).

- Using a population of reference lakes a multivariate regression model was constructed to predict the expected reference LMNI for each lake from characteristics of the catchment geology, location, lake depth and area. (Eqn 1 Appendix 2).
- This, together with a set of environmental variables, is then used to calculate an EQR based on the plantcommunity response to nutrients. Survey data are accorded a weighted value that varies depending on the distribution of macrophytes in each water-body. Percentage cover for each species recorded is a mean of these values, and is used to calculate the % cover EQR.
- EQRs for relative cover of filamentous algae, number of taxa and number of functional groups are also calculated.
- The final EQR is based on a set of rules that determine the average of these EQRs. A weighting is used to reflect the fact that over a natural fertility gradient (naturally oligotrophic – eutrophic) the relative importance of the above metrics changes. At low fertility, changes in taxonomic composition (LMNI EQR) reflect increased pressure, while at high (natural) fertility changes in both the number of taxa and taxonomic composition reflect increased pressure.

Data requirements

Table 1. Typical input table from a UK lake survey

Species	% cover
Chara aspera	10
Nitellopsis obtusa	2
Potamogeton obtusifolius	5
Nymphaea alba	10
Hippuris vulgaris	5
elodea canadensis	1

In addition environmental parameters are required in order to calculate site specific "expected" or reference values for each metric (see equations in Appendix 2 for details). It is expected that these will be fixed values for each site and are obtained from a standard data set rather than input as part of the survey data.

Methods of calculation

Example

1. Determine species composition EQR using LMNI index (metric a)

An LCB2 lake with alkalinity of 1.7 meq/L, average depth 2.7m (MEI=0.63), altitude of 15m and area of 3.1ha, supports a macrophyte assemblage of *Chara aspera*, *Nitellopsis obtusa*, *Potamogeton obtusifolius*, *Nymphaea alba*, *Hippuris vulgaris* and *Elodea canadensis*.

The **observed LMNI** score for the lake is the average of the ranks for the individual species:

$$\text{Observed LMNI} = \frac{(7.1 + 7.62 + 6.72 + 5.54 + 6.4 + 7.14)}{6} = 6.75$$

The **expected LMNI** score for this site under reference condition is calculated using an equation derived from multiple regression with a set of variables from UK reference lakes including: alkalinity, conductivity, lake area, altitude, drift geology, freshwater sensitivity class and distance to nearest coast. (Equation 1 in Appendix 2).

This results in an expected LMNI score of 5.48.

The EQR for this lake using the LMNI metric alone is:

$$\text{LMNI EQR} = \frac{(6.75 - 10)}{(5.48 - 10)} = 0.72$$

Note that both the observed and the expected values have 10 subtracted from them. This reflects the theoretical maximum (worst) LMNI site score of 10, and ensures that low LMNI scores achieve a high EQR. The lake status based on this metric alone would be Moderate (i.e. LMNI EQR of between 0.67 and 0.79).

2. Determine functional diversity as number of functional groups EQR (metric b)

The observed number of functional groups (NFG) for this lake is 5

(*Chara aspera* and *Nitellopsis obtusa* are in group 2, *Potamogeton obtusifolius* group 14, *Nymphaea alba* group 12, *Hippuris vulgaris* group 7 and *Elodea canadensis* is in group 5).

The expected number of functional groups is derived from an equation based on the relationship between NFG, altitude, alkalinity and lake area (Equation 2, Appendix 2). The equation predicts log (NFG+1).

The expected number of functional groups would be 6.36.

$$\text{The NFG EQR} = \frac{Log.(ObservedNFG+1)}{Log.(PredictedNFG+1)}$$

This gives a NFG EQR of 0.90, and an adjusted EQR = 0.91[3].

3. Determine taxonomic diversity as number of taxa EQR (metric c)

The observed number of taxa (NT) is 6. The expected number of taxa is produced by Equation 3 in Annex B. This utilises the same environmental parameters as the number of functional groups and predicts log (NT+1).
In this case the expected number of taxa would be 8.93.

$$\text{The NT EQR} = \frac{Log.(ObservedNT+1)}{Log.(PredictedNT+1)}$$

This gives an NT EQR of 0.85, and an adjusted EQR = 0.87.

4. Determine % cover EQR (metric d)

The observed % cover in this example is:
Chara aspera 10%, *Nitellopsis obtusa* 2%, *Potamogeton obtusifolius* 5%, *Nymphaea alba* 10%, *Hippuris vulgaris* 5%and *Elodea canadensis* 1%.

This gives an observed mean cover per taxa of 5.5%.

For the cover metric no model could be developed as the amount of cover in reference sites was unrelated to the available environmental data. Therefore the median of the reference set was used (8.5% mean cover). It must be noted that the % cover is % cover of the colonised zone and not % cover of the whole lake.

$$\text{\% Cover EQR} = \frac{Log.(Observed mean\% cover+1)}{Log.(8.5+1)}$$

Which is an EQR of 0.83 for this example, and adjusted EQR = 0.88.

5. Determine % macro algae (metric e)

No GIG data are available so this metric is not used for intercalibration purposes.

3 Ajustment of EQRs to a harmonised scale, as described in Appendix 2

Where data are available, the EQR for % macro algae cover is determined from the following equation. As for % cover, no model of reference cover could be determined so a fixed reference condition of 0.05 is used.

If macro-algal cover is > 0.05 then EQR is given by: $\dfrac{(MacroAlCover - 1)}{(0.05 - 1)}$

If macro-algal cover is <0.05 then EQR is 1

6. Combine EQRs using the following rules:

a) EQRs are adjusted (adj EQR) so that differences in class boundary positions between individual metrics are harmonised to the boundaries used for LMNI. (Appendix 1, Equation 5)

b) Determine the maximum indicator of diversity[4] and adjust the LMNI EQR to give EQR_p:

- If the values of both the adj NFG EQR and the adj NT EQR are less than the LMNI EQR, the mean of the LMNI EQR and the greater of adj NFG EQR or adj NT EQR is calculated.

  - If the value of the adj NFG EQR or the adj NT EQR is greater than the LMNI EQR then the greater of adj NFG EQR or adj NT EQR is multiplied by a weighting factor and added to the LMNI EQR . This product is then divided by the weighting factor plus unity.

$$\frac{\left(LMNIEQR \ + weighting * Max(FGEQR, NTEQR\right)}{1 + weighting}$$

The weighting factor (Appendix 2) is designed to compensate for an expected increase in productivity of high alkalinity lakes and the associated decrease in richness with increasing nutrient pressure in such lakes. This therefore increases the EQR of diverse relative to impoverished high alkalinity sites with the same LMNI EQR. In moderate and low alkalinity lakes the weighting factor gives the diversity metric EQRs a neutral influence.

c) Determine the lower of the EQRs for hydrophyte % cover and macro-algae, and adjust the diversity modified LMNI EQR (EQR_p)

If the diversity modifed LMNI EQR (EQR_p) is greater than the minimum of the adj % Cover EQR or the adj % algal EQR, the final EQR is determined from the following weighted average. This has the consequence of lowering the final EQR of sparsely vegetated sites.

$$\frac{\left(EQR_p + 0.5 * Min(\%CoverEQR, MacAlEQR\right)}{1.5}$$

a) [4] both functional groups and number of taxa are used to reflect changes in functional diversity and potentially different levels of taxonomic recording influencing the metric

If diversity modifed LMNI EQR (EQR_p) is less than the adj % Cover EQR or adj % algal EQR, the modified LMNI EQR (EQR_p) is used as the final EQR.

In this example the maximum of the NFG EQR and NT EQR is 0.91. This is greater than the LMNI EQR (0.72) so the diversity adjusted LMNI EQR (EQR_p)is given by

$$0.78 = \frac{(0.72 \ + 0.41 * 0.91)}{1 + 0.41}$$

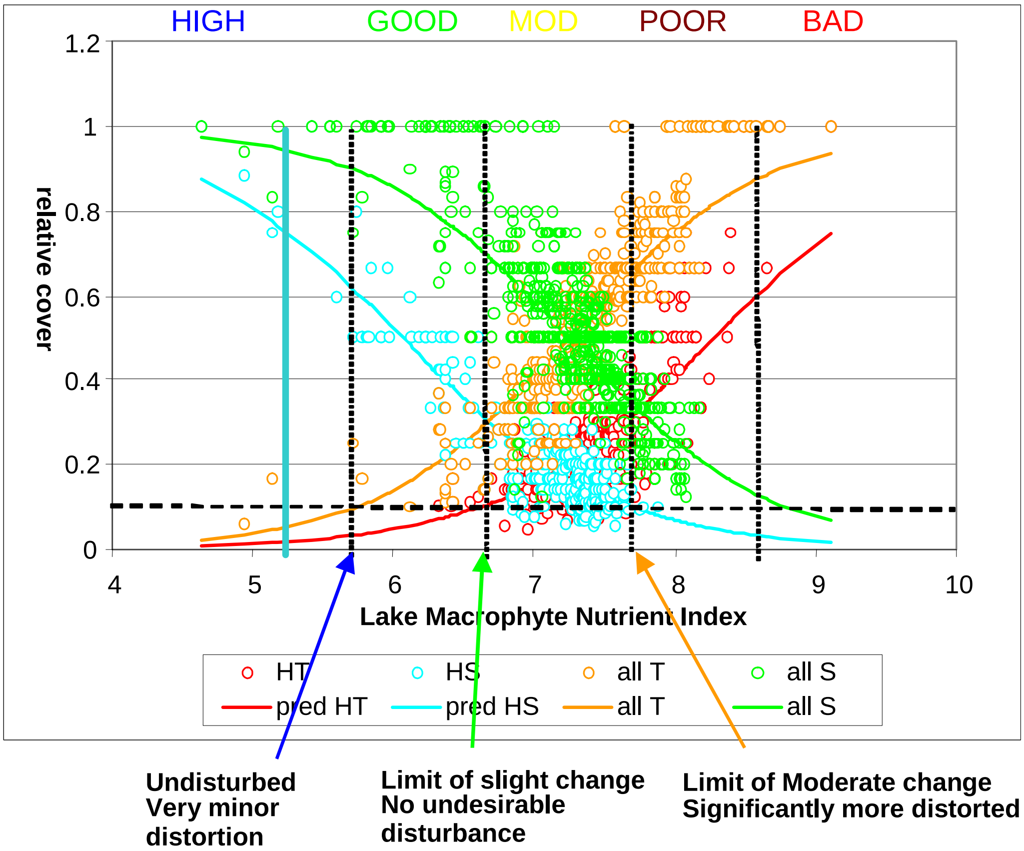
This value is less than the adjusted cover EQR (0.88) and is thus the final EQR. This would place the example given on the G/M boundary.

How are reference conditions, H/G and G/M boundaries derived?

Reference sites were identified at a type-specific level using individual species-pressure relationships indicated by empirical analysis, historical macrophyte records and expert opinion. A conceptual framework (Figure 1), based on changes in the relative abundance of different functional response groups along a pressure gradient, was developed in order to guide the placement of class boundaries in a manner consistent with the normative definitions. The combined population of reference sites drawn from all types was then used to derive the reference metric values needed to calculate EQRs for the whole lake population. Some sites not initially considered reference at the type-specific screening stage were found, after site specific modelling, to have EQR values much higher than the H/G boundary and these were relocated to the reference site pool. Similarly a minority of sites (1%) originally identified as reference were found to have EQR values lower than the G/M boundary and were consequently removed from the reference site pool. A number of iterations were carried out to provide a final set of reference sites and associated models. This method assumes that the pressure gradient length used in the overall data set is similar for all lake types. This was checked by comparing median type specific reference values with values derived by logistic regression using modelled reference values (derived from a MEI model). Finally all reference sites remaining were checked against land cover and total P data where available, and sites with known hydromorphological modifications were removed.

Class boundaries have been set using the conceptual model illustrated in figure 1, and are related to the normative definitions of the Directive. Macrophytes were placed into 4 nutrient response groups using empirical analysis (Highly sensitive, sensitive, tolerant and highly tolerant). The ratio of the relative cover of these response groups was then related to the macrophyte nutrient score (LMNI) itself an index of nutrient pressure (Fig 1). Boundary values for HG and GM were determined from this relationship. The HG boundary was identified as the point at which all tolerant species were on average < 10% of cover. The GM boundary was the point at which the lower confidence limits of the sensitive and upper confidence limit of the tolerant species intersect. At this point there is still a high probability of having >50% cover of sensitive species and no more than 50% cover of tolerant species. This would be indicative of slight change, the community could still easily recover to its original status. The highly sensitive species are still present (10-50% cover) and highly tolerant (undesirable) species would be < 20% cover. The P/B boundary was set where the lower confidence limit of the sensitive and upper confidence limit of the tolerant species intersect. At this point there is a low probability that sensitive species would be at 50% cover, but a high probability that tolerant species would be at 50% cover. Very sensitive species are still present, but the community has thus undergone a moderate change . The P/B boundary is a point at which highly sensitive species are extinct and there are very few sensitive species. Here the community is dominated by tolerant species

Figure 1. Conceptual framework for the determination of classification boundaries by comparison of relative cover of species that are highly tolerant to eutrophication (HT), highly sensitive (HS), tolerant (T) and sensitive species (S)



The actual EQR boundaries for each class are shown below:

High		Good		Moderate		Poor		Bad
← →	0.91	← →	0.79	← →	0.67	← →	0.55	→

How well do these indicators correlate with pressure indicators?

The relationship between LMNI and Total P (annual mean) in the UK dataset is summarised in figure 2 below. This index performs extremely well as an independent model and is only fractionally inferior (r^2 of 0.47 compared to 0.49) to an internally validated model that is based on CCA derived site scores in which the species scores are determined by their optima on the measured P gradient.

The best LMNI v TP model was obtained by sequentially removing sites with very low numbers of species. Thus this model excludes sites with five or fewer species. This model also includes annual mean TP data that was predicted from summer mean or spot samples only (r^2 of 0.97 for summer v annual TP with 850 samples). The model performs slightly less well than the best river model (r^2 of 0.59) which may reflect the greater spatial heterogeneity of nutrient supply in lakes and the fact that lake macrophytes are probably deriving proportionally more of their nutrients from the sediment than in rivers.

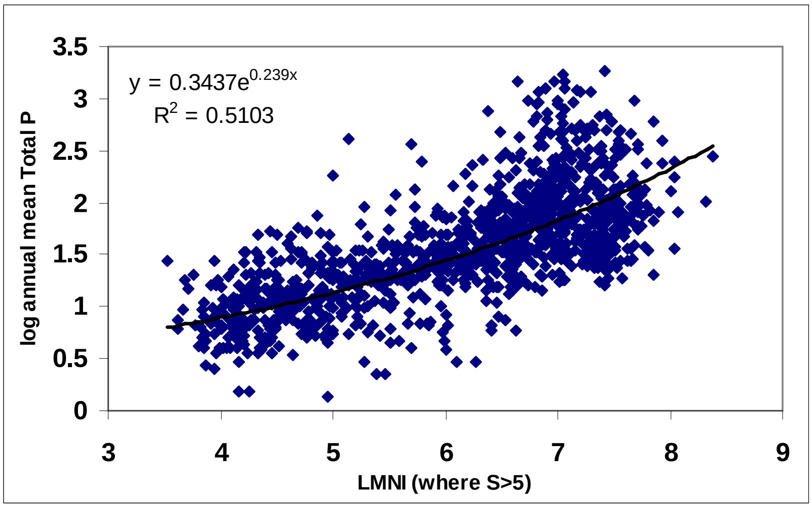


Figure 2. Global relationship between LMNI and lake Total P (annual mean).

Appendix 1 UK Species list

Species	LMNI score	Functonal group	CGIG Species
Alisma gramineum	5.57	13	
Apium inundatum	5.69	7	
Aponogeton distachyos	7.38	16	
Azolla filiculoides	9.28	1	
Baldellia ranunculoides	5.58	13	
Batrachospermum	3.02		
Brachythecium sp.	6.37	3	
Bryales (aquatic indet)	5.38	3	
Butomus umbellatus	8.46	13	
Calliergon sp.	7.71	3	
Callitriche agg.	6.33	6	
Callitriche brutia	6.49	6	
Callitriche cophocarpa	5.97	6	MS_CAL1COP1_COM1
Callitriche hamulata	5.47	6	MS_CAL1HAM1_COM1
Callitriche hermaphroditica	6.71	5	MS_CAL1HER1_COM1
Callitriche obtusangula	7.83	6	
Callitriche palustris	5.19	6	MS_CAL1PAL1_COM1
Callitriche platycarpa	7.45	6	
Callitriche stagnalis	5.98	6	MS_CAL1STA1_COM1
Callitriche truncata	8.35	6	
Ceratophyllum demersum	8.67	5	MS_CER1DEM1_COM1
Ceratophyllum sp.	8.50	5	
Ceratophyllum submersum	8.82	5	MS_CER1_SUB1
Chara aspera	7.10	2	MS_CHA1ASP1_COM1
Chara aspera var.aspera	5.99	2	
Chara aspera var.aspera f.subinermis	5.47	2	
Chara aspera var.curta	6.52	2	
Chara aspera var.lacustris	6.00	2	
Chara baltica	8.60	2	MS_CHA1BAL1_COM1
Chara canescens	8.13	2	
Chara connivens	7.92	2	MS_CHA1CON1_COM1
Chara contraria var. hispidula	8.20	2	MS_CHA1CON2_COM1
Chara filiformis	6.96	2	MS_CHA1FIL1_COM1
Chara globularis sens.lat	7.34	2	MS_CHA1GLO1_COM1
Chara globularis var.annulata	5.62	2	
Chara globularis var.globularis (= fragilis)	6.60	2	MS_CHA1FRA1_COM1
Chara globularis var.virgata (= delicatula)	5.55	2	MS_CHA1DEL1_COM1
Chara globularis var.virgata f.barbata	5.31	2	
Chara hispida sens.lat.	6.87	2	MS_CHA1HIS1_COM1
Chara hispida var.rudis (=Chara rudis)	6.94	2	
Chara intermedia	8.00	2	MS_CHA1INT1_COM1
Chara pedunculata	6.54	2	
			MS_CHA1RUD1_COM1
Chara sp	5.86	2	MS_CHA1ZZZ1_COM1
Chara strigosa	6.14	2	MS_CHA1STR1_COM1
Chara tomentosa	7.06	2	MS_CHA1TOM1_COM1
Chara vulgaris	7.19	2	MS_CHA1VUL1_COM1

Chara vulgaris sensu Stewart	6.47	2	
Chara vulgaris var. longibracteata	8.37	2	
Chara vulgaris var. papillata	7.21	2	
Chara vulgaris var.contraria	7.47	2	
Chara vulgaris var.hispidula	6.92	2	
Chara vulgaris var.vulgaris	7.35	2	
Charophyta (indet)	6.66	2	MS_CHA2ZZZ1_COM1
Cinclidotus fontinaloides	5.18	3	
Crassula aquatica	5.59	11	MS_CRA2AQU1_COM1
Crassula helmsii	6.18	5	
Damasonium alisma	4.64	13	
Drepanocladus fluitans	6.65	3	
Elatine hexandra	5.41	11	MS_ELA1HEX1_COM1
Elatine hydropiper	7.39	11	MS_ELA1HYD1_COM1
Elatine orthosperma	4.90	11	MS_ELA1ORT1_COM1
Elatine triandra	6.09	11	MS_ELA1TRI1_COM1
Eleocharis acicularis	6.75	4	MS_ELE1ACI1_COM1
Eleocharis multicaulis	1.93	4	
Eleogiton fluitans	3.45	15	
Elodea callitrichoides	7.92	5	
Elodea canadensis	7.14	5	MS_ELO1CAN1_COM1
Elodea nuttallii	6.92	5	MS_ELO1NUT1_COM1
Elodea spp	6.45	5	
Enteromorpha	8.42	1	
Eriocaulon aquaticum	1.67	4	
Filamentous algae	6.39	1	MS_ALG1ZZZ1_COM1
Fisidens sp.	7.30	3	
Fontinalis antipyretica	5.42	3	
Fontinalis squamosa	4.56	3	
Fucus	7.86		
gelatinous algae	6.43		
Groenlandia densa	6.49	5	
Hepatica (aquatic indet.)	3.55	3	
Hildenbrandia	5.84		
Hippuris vulgaris	6.40	7	
Hottonia palustris	7.33	7	
Hydrilla verticillata	7.16	5	MS_HYD1VER1_COM1
Hydrocharis morsus-ranae	8.26	8	MS_HYD2MOR1_COM1
Hydrodictyon	9.11	1	
Hypericum elodes	4.95	11	
Isoetes	4.72	4	
Isoetes echinospora	4.06	4	MS_ISO1ECH1_COM1
Isoetes lacustris	3.09	4	MS_ISO1LAC1_COM1
Juncus bulbosus	3.72	4	
Lagarosiphon major	7.42	5	
Lemna gibba	9.24	1	MS_LEM1GIB1_COM1
Lemna minor	7.58	1	MS_LEM1MIN1_COM1
Lemna minuta	8.64	1	
Lemna trisulca	7.82	1	MS_LEM1TRI1_COM1
Leptodyctium riparium	8.44	3	
Limosella aquatica	6.49	11	MS_LIM1AQU1_COM1
Littorella uniflora	4.70	4	MS_LIT1UNI1_COM1
Lobelia dortmanna	2.46	4	MS_LOB1DOR1_COM1
Ludwigia palustris	5.57	11	
Luronium natans	5.13	13	

Lycopodiella inundata	3.01	3
Lythrum portula	5.56	11
Menyanthes trifoliata	4.76	10
Myriophyllum alterniflorum	4.54	7 MS_MYR1ALT1_COM1
Myriophyllum aquaticum	4.64	7
Myriophyllum sibiricum	6.14	7 MS_MYR1SIB1_COM1
Myriophyllum sp.	7.91	7
Myriophyllum spicatum	7.84	7 MS_MYR1SPI1_COM1
Myriophyllum verticillatum	8.67	7 MS_MYR1VER2_COM1
Najas flexilis	5.39	14 MS_NAJ1FLE1_COM1
Najas marina	8.84	14 MS_NAJ1MAR1_COM1
Najas tenuissima	6.60	14 MS_NAJ1TEN1_COM1
Nitella	5.26	2
Nitella confervacea	4.91	2 MS_NIT1CON1_COM1
Nitella flexilis agg.	5.60	2 MS_NIT1FLE1_COM1
Nitella gracilis	4.38	2
Nitella mucronata	8.42	2 MS_NIT1MUC1_COM1
Nitella opaca	5.27	2 MS_NIT1OPA1_COM1
Nitella translucens	5.17	2 MS_NIT1TRA1_COM1
Nitella wahlbergiana	7.00	2 MS_NIT1WAH1_COM1
Nitellopsis obtusa	7.62	2 MS_NIT2OBT1_COM1 MS_NIT1_SYN1
Nuphar lutea	6.92	12 MS_NUP1LUT1_COM1
Nuphar lutea x pumila (N. x spenneriana)	5.61	12 MS_NUP1SPE1_COM1
Nuphar pumila	5.33	12 MS_NUP1PUM1_COM1
Nymphaea (exotics)	5.63	12 MS_NYM1ALX1_COM1
Nymphaea alba	5.54	12 MS_NYM1ALB1_COM1
Nymphaea candida	7.70	12 MS_NYM1CAN1_COM1
Nymphaea tetragona	5.26	12 MS_NYM1TET1_COM1
Nymphoides peltata	8.07	10 MS_NYM2PEL1_COM1 MS_NYM1XAL1_COM1
Oenanthe aquatica	8.31	7
Persicaria amphibia	7.25	10 MS_PER1AMP1_COM1
Pilularia globulifera	5.18	4
Potamogeton acutifolius	7.48	14 MS_POT1ACU1_COM1
Potamogeton alpinus	5.79	16 MS_POT1ALP1_COM1
Potamogeton alpinus x praelongus (P. x griffithii)	5.24	16
Potamogeton berchtoldii	6.07	14 MS_POT1BER1_COM1
Potamogeton coloratus	6.70	16
Potamogeton compressus	8.00	14 MS_POT1COM1_COM1
Potamogeton crispus	7.64	17 MS_POT1CRI1_COM1
Potamogeton epihydrus	2.78	16
Potamogeton filiformis	6.16	15 MS_POT1FIL1_COM1
Potamogeton filiformis x pectinatus (P. x suecicus)	6.11	15 MS_POT1XSU2_COM1
Potamogeton friesii	7.64	14 MS_POT1FRI1_COM1
Potamogeton friesii x crispus (P x lintonii)	8.35	14
Potamogeton gramineus	5.51	16 MS_POT1GRA1_COM1
Potamogeton gramineus x lucens (P. x zizii)	5.69	16 MS_POT1XZI1_COM1
Potamogeton gramineus x natans (P. x sparganiifolius)	5.54	16 MS_POT1XSP1_COM1

Potamogeton gramineus x perfoliatus (P. x nitens)	5.60	17 MS_POT1XGR2_COM1
Potamogeton gramineus/P.x nitens	5.56	17
Potamogeton lucens	7.02	17 MS_POT1LUC1_COM1
Potamogeton lucensx perfoliatus (P x salicifolius)	6.89	17
Potamogeton natans	5.16	16 MS_POT1NAT1_COM1
Potamogeton natans x polygonifolius (P. x gessnacensis)	6.42	16
Potamogeton obtusfolius/P.berchtoldii	7.38	14
Potamogeton obtusifolius	6.72	14 MS_POT1OBT1_COM1
Potamogeton pectinatus	8.25	15 MS_POT1PEC1_COM1
Potamogeton pectinatus/filiformis indet.	7.80	15
Potamogeton perfoliatus	5.83	17 MS_POT1PER1_COM1
Potamogeton perfoliatus/xnitens indet.	5.06	17
Potamogeton polygonifolius	3.50	16 MS_POT1POL1_COM1
Potamogeton praelongus	5.77	16 MS_POT1PRA1_COM1
Potamogeton pusillus	7.61	14 MS_POT1PUS1_COM1
Potamogeton rutilus	5.62	14 MS_POT1RUT1_COM1
Potamogeton sp.	7.02	14
Potamogeton trichoides	8.39	14 MS_POT1TRI1_COM1
Potamogeton vaginatus	6.29	15 MS_POT1VAG1_COM1
Potamogeton x cooperi	5.67	17
Racomitrium sp.	6.06	3
Ranunculus	5.88	18
Ranunculus aquatilis agg.	6.50	18
Ranunculus aquatilis sens.str.	6.61	18 MS_RAN1AQU1_COM1
Ranunculus baudotii	6.82	18
Ranunculus circinatus	8.64	5 MS_RAN1CIR1_COM1
Ranunculus confervoides	5.60	18 MS_RAN1CON1_COM1
Ranunculus fluitans	7.42	18
Ranunculus hederaceus	6.60	11
Ranunculus lingua	7.61	10
Ranunculus omiophyllus	5.76	11
Ranunculus peltatus	6.48	18 MS_RAN1PEL1_COM1
Ranunculus penicillatus	6.49	18
Ranunculus penicillatus var penicillatus	5.78	18
Ranunculus reptans	4.88	11 MS_RAN1REP2_COM1
Ranunculus sp.	5.91	18
Ranunculus trichophyllus	6.68	18
Riccia fluitans	6.63	1
Riccia sp.	5.99	1
Ricciocarpus natans	6.30	1
Ruppia cirrhosa	8.13	15
Ruppia maritima	10.00	15
Ruppia sp	9.66	15
Sagittaria natans	5.64	13 MS_SAG1NAT1_COM1
Sagittaria sagittifolia	7.88	12 MS_SAG1XSA1_COM1
Salvinia natans	9.34	1 MS_SAL1NAT1_COM1
Scapania sp.	6.68	3
Scorpidium scorpioides	4.56	3

Solenostoma sp	5.99	3	
Sparganium	5.65	13	
Sparganium angustifolium	3.65	13	MS_SPA1ANG1_COM1
Sparganium angustifolium/natans	4.29	13	
Sparganium emersum	6.59	13	
			MS_SPA1_ERE1
Sparganium gramineum	5.52	13	MS_SPA1GRA1_COM1
Sparganium hyperboreum	2.76	13	MS_SPA1HYP1_COM1
Sparganium natans	4.84	13	MS_SPA1NAT1_COM1
			MS_SPA1XAN1_COM1
Sphagnum (aquatic indet.)	3.37	3	
Spirodela polyrhiza	8.79	1	MS_SPI1POL1_COM1
Stratiotes aloides	8.51	8	MS_STR1ALO1_COM1
Subularia aquatica	2.93	4	MS_SUB1AQU1_COM1
Tolypella canadensis	5.13	2	MS_TOL1CAN1_COM1
Tolypella glomerata	7.18	2	MS_TOL1GLO1_COM1
Trapa natans	8.91	8	MS_TRA1NAT1_COM1
Utricularia	4.31	9	MS_UTR1ZZZ1_COM1
Utricularia australis	4.65	9	MS_UTR1AUS1_COM1
Utricularia cf. australis	4.84	9	
Utricularia cf. vulgaris	5.44	9	
Utricularia intermedia sens.lat.	2.74	9	MS_UTR1INT1_COM1
Utricularia minor	2.97	9	MS_UTR1MIN1_COM1
Utricularia ochroleuca	1.00	9	MS_UTR1OCH1_COM1
Utricularia stygia	2.06	9	
Utricularia vulgaris sens.lat.	5.39	9	MS_UTR1VUL1_COM1
Utricularia vulgaris sens.str.	5.13	9	
Wolffia arrhiza		1	
Zannichellia palustris	8.49	15	MS_ZAN1PAL1_COM1
Zostera angustifolia/n	6.49	13	

Appendix 2 Equations

1) Expected (reference) LMNI score:

LMNI = 1.605095 + 0.635498* (log(alkalinity +40) + -0.53082*(log (Zmn)) + 0.113708*(wtd FSC) + 0.440744*(log(conductivity) + 9.41E-03* NRDIST2C + 0.17256 * log(area) + -0.00193 * FWSC2 + 0.00196 * SGEOL_CA.
Where: alkalinity is in □eq./L, mean depth (Zmn) in m, wtdFSC (mean Freshwater Sensitivity class of catchment geology weighted by % cover in catchment), conductivity in uScm, NRDIST2C (nearest distance to coast) in km, area in ha, FWSC2 (cover of Freshwater Sensitivity class 2) as % of catchment, SGEOL_CA (cover of calcareous solid geology) as % of catchment.

[For CGIG Lakes where environmental data limited the following simplified equation as used:
LMNI (CGIG) = 0.9333*(log(alkalinity/mean depth))+5.4937,
Where alkalinity is in meql./L and depth is in m.]

2) Expected number of functional groups (i.e. predicts log (N_FG+1)):
0.2566347 + - 0.00020472 * ((alkalinity*1000)+40) + 0.26551458 * (Log.((alkalinity*1000)+40)) + 2.94538463516568E-08 * (((alkalinity*1000)+40)^2)+-1.40898925977951E-12*(((alkalinity*1000)+40)^3)+-0.00028913*altitude+0.03255904*Log.lake area.

3) Expected number of taxa (i.e. predicts log (N_TAXA+1))
0.554544+-0.000278*(alkalinity+40)+0.270098*(log alk+40)+0.0000000421*((alk+40)^{2})+-0.00000000000205*((alk+40)^{3})+-0.092317*(log altitude)+7.45721828406972E-07*(altitude^{2})+-1.37193346236172E-09*(altitude^{3})+0.060514*(log area**)**
Where alkalinity is in □eq./L and area in ha.

4) Weighting factor
(1/(EXP(LN(2624653085.79034) +expected LMNI* LN(0.0165738290871162))+1/0.5001))

In order to fit the above models to the CGIG common dataset the environmental data supplied by individual countries were used. Where values were missing these were replaced by the median for the type across all sites from which values were available, except in the case of alkalinity which was poorly populated and was therefore based on the median values for the IC types as found in the UK dataset. In order to apply the prediction of LMNI a set of substitute models was devised based on the morpho-edaphic index, to accommodate the limited range of environmental predictors available in the CGIG common dataset. Correction factors were then applied to bring the predicted values in line with the median expected LMNI values (as modelled by the full set of environmental predictors) for members of the IC lake types in the UK database.

5) Adjustment of EQRs to LMNI scale prior to weighted averaging
adj N_TAXA EQR = 0.95N_TAXA EQR + 0.062
adj N_FG EQR = 0.95 N_FG EQR +0.062
adj Cover EQR = 0.76 Cover EQR + 0.252
adj M_Alg EQR = 1.305 Alg EQR^{3} + 2.1239 Alg EQR^{2} + 1.5245 Alg EQR + 0.2802.
(If M_Alg EQR = 1) adj M_Alg EQR is set to null

Case LV: **Macrophytes as lakes` water ecological quality elements in Latvia**

Though the national assessment method is planned to be used for the first River Basin Management Plan, a clear view on the details of the program of montoring for macrophytes is not yet finalized. Therefore, no further information can be provided. Also further testing of the metod should be done and the boundaries can be better desribed and justified. Also its relationship with pressure needs attention. Nonetheless, the performance of the Latvian metric on European lakes and data is good.

In order to report an EQR value the different classes are assigned with the following values: Bad 0.00; Poor 0.30; Moderate 0.50; Good 0.7; High 1, where 0.2, 0.4, 0.6, 0.8 are the boundaries vor B/P; P/M; M/G; and G/H respectively. The median value of all parameters represents the final assessment of the quality element macrophytes.

Macrophyte composition and occurrence

Type 1: Very shallow (< 2 m) **clear water lake** (< 80 Pt-Co) **with high water hardness** (> 165 mkS/cm)

Parameter of ecological quality	High	Good	Average	Bad	Very bad
Indicator species	Chara sp., Nitella sp. (dominating), Najas marina, Stratiotes aloides	Chara sp., Nitella sp., Cladium mariscus Najas marina Stratiotes aloides	Chara sp., Nitella sp.	Chara sp., Nitella sp.	Not occurring
Presence of indicator species	Dominating	Dominating	Frequent	Rare	Not occurring
Overgrowth with indicator species	>50%	<50%	10-30%	<10%	
Total overgrowth	>80%	>80%	>80%	>80%	>80%

Type 2: Very shallow coloured water lake with high water hardness

Parameter of ecological quality	High	Good	Average	Bad	Very bad
Indicator species	Myriophyllum lterniflorum Cladium mariscus Chara sp., Nitella sp., Najas marina	Cladium mariscus Myriophyllum alterniflorum Chara sp., Nitella sp.,	Chara sp., Nitella sp.	Chara sp., Nitella sp.	Not occurring
Presence of indicator species	Dominating	Frequent	Frequent	Rare	Not occurring
Overgrowth with indicator species	>50%	>50%	<10%	<1%	
Total overgrowth	>50%	>70%	>70%	>50%	>50%

Type 3: Very shallow clear water lake with low water hardness

Parameter of ecological quality	High	Good	Average	Bad	Very bad
Indicator species	Isoetes lacustris, I.echinospora, Lobelia dortmanna, Litorella uniflora, Subularia aquatica, Sparganium affine	Isoetes lacustris, I.echinospora, Lobelia dortmanna, Litorella uniflora, Subularia aquatica, Sparganium affine	Isoetes lacustris, I.echinospora, Lobelia dortmanna, Litorella uniflora, Subularia aquatica, Sparganium affine	Not occurring	Not occurring

Presence of indicator species	Frequent	Frequent	Rare	Not occurring	Not occurring
Overgrowth with indicator species	>5%	<5%	<1%	Not occurring	Not occurring
Total overgrowth	<30%	<30%	>30%	>30%	>30%

Type 4: Very shallow coloured water lake with low water hardness

Parameter of ecological quality	High	Good	Average	Bad	Very bad
Indicator species	Sphagnum riparium fluitans Utricularia minor, Nuphar lutea	Sphagnum riparium fluitans, Utricularia minor, Nuphar lutea	Sphagnum riparium fluitans, Utricularia minor, Nuphar lutea	Rare	Not occurring
Presence of indicator species	Frequent	Frequent	Rare	Not occurring	Not occurring
Overgrowth with indicator species	>5%	<5%	<5%	<1%	Not occurring
Total overgrowth	<30%	<30%	<30%	<30%	<10%

Type 5: Shallow (2-9 m) **clear water lake with high water hardness**

Parameter of ecological quality	High	Good	Average	Bad	Very bad
Indicator species	Chara sp., Nitella sp., Myriophyllum alterniflorum, Stratiotes aloides, Potamogeton lucens	Chara sp., Nitella sp., Myriophyllum alterniflorum, Stratiotes aloides, Potamogeton lucens	Chara sp., Nitella sp., Myriophyllum alterniflorum, Stratiotes aloides, Potamogeton lucens	Chara sp., Nitella sp., Potamogeton lucens	Not occurring
Presence of indicator species	Frequent	Frequent	Rare	Rare	Not occurring
Overgrowth with indicator species	>5%	<5%	<5%	<1%	Not occurring
Total overgrowth	>30%	>50%	>50%	>50%	>50%

Type 6: Shallow coloured water lake with high water hardness

Parameter of ecological quality	High	Good	Average	Bad	Very bad
Indicator species	Chara sp., Nitella sp., Myriophyllum alterniflorum, Stratiotes aloides, Potamogeton lucens	Chara sp., Nitella sp., Myriophyllum alterniflorum Stratiotes aloides, Potamogeton lucens	Chara sp., Nitella sp., Myriophyllum alterniflorum Stratiotes aloides, Potamogeton lucens	Chara sp., Nitella sp., Myriophyllum alterniflorum, Stratiotes aloides, Potamogeton lucens	Not occurring
Presence of indicator species	Frequent	Frequent	Frequent	Rare	Not occurring
Overgrowth with indicator species	>5%	<5%	<5%	<1%	Not occurring
Total overgrowth	>30%	>50%	>50%	>50%	>50%

Type 7: Shallow clear water lake with low water hardness

Parameter of ecological quality	High	Good	Average	Bad	Very bad
Indicator species	Isoetes lacustris, I.echinospora, Lobelia dortmanna, Litorella uniflora, Myriophyllum alterniflorum	Isoetes lacustris, I.echinospora, Lobelia dortmanna, Litorella uniflora, Myriophyllum alterniflorum	Isoetes lacustris, I.echinospora, Lobelia dortmanna, Litorella uniflora, Myriophyllum alterniflorum	Not occurring	Not occurring
Presence of indicator species	Frequent	Frequent	Rare	Not occurring	Not occurring
Overgrowth with indicator species	>5%	<5%	<1%	Not occurring	Not occurring
Total overgrowth					

Type 8: Shallow coloured water lake with low water hardness

Parameter of ecological quality	High	Good	Average	Bad	Very bad
Indicator species	Nuphar lutea, Isoetes lacustris, Sphagnum riparium fluitans	Nuphar lutea, Isoetes lacustris, Sphagnum riparium fluitans	Nuphar lutea, Sphagnum riparium fluitans	Nuphar lutea	Not occurring
Presence of indicator species	Present	Present	Rare	Rare	Not occurring
Overgrowth with indicator species	>1%	<1%	<1%	<1%	Not occurring
Total overgrowth	>5%	>5%	>5%	>5%	>5%

Type 9: Deep (> 9 m) **clear water lake with high water hardness**

Parameter of ecological quality	High	Good	Average	Bad	Very bad
Indicator species	Chara sp., Nitella sp.,	Chara sp., Nitella sp.,	Chara sp., Nitella sp.,	Not occurring	Not occurring
Presence of indicator species	Present	Present	Rare	Not occurring	Not occurring
Overgrowth with indicator species	>1%	<1%	<1%	Not occurring	Not occurring
Total overgrowth	<10%	<10%	>10%	>10%	>10%

Type 10: Deep clear water lake with low water hardness

Parameter of ecological quality	High	Good	Average	Bad	Very bad
Indicator species	Isoetes lacustris, I.echinospora, Lobelia dortmanna, Litorella uniflora, Subularia aquatica, Myriophyllum alterniflorum	Isoetes lacustris, I.echinospora, Lobelia dortmanna, Litorella uniflora, Subularia aquatica Myriophyllum alterniflorum	Isoetes lacustris, I.echinospora, Lobelia dortmanna, Litorella uniflora, Subularia aquatica, Myriophyllum alterniflorum	Not occurring	Not occurring
Presence of indicator species	Present	Present	Rare	Not occurring	Not occurring
Overgrowth with indicator species	>1%	<1%	<1%	Not occurring	Not occurring
Total overgrowth	<10%	<30%	>30%	>30%	>30%

Annex B – Part 2 - Relationships between the averaged Member States opinion on macrophyte composition and eutrophication indicators.

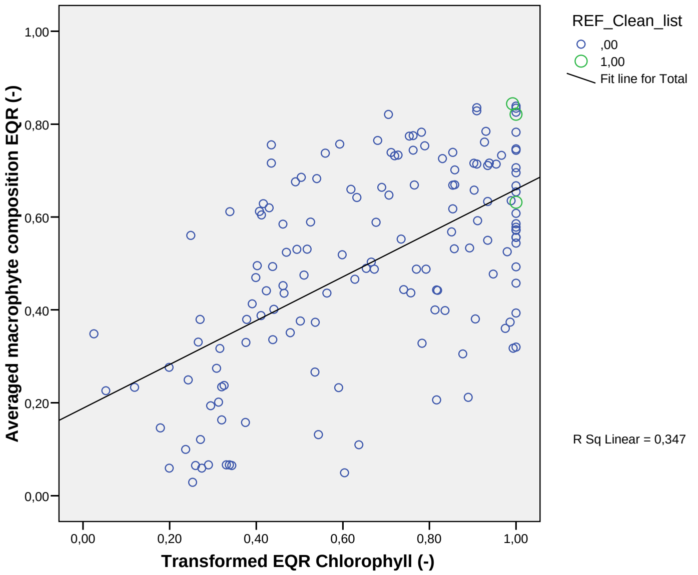


Figure B-2-1. Relationship between the averaged EQR of macrophyte composition of all compliant Member States and the transformed EQR of chlorophyll-a for LCB2.

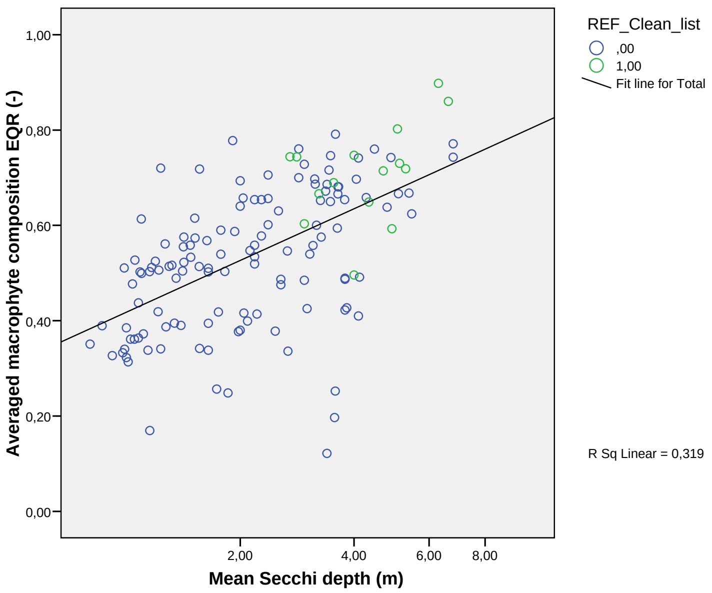


Figure B-2-2. Relationship between the averaged EQR of macrophyte composition of all compliant Member States and Secchi depth.

Annex B Part 3 – Application of national assessment systems to common database

Table B-3-1 Adaptation of abundance classes for assessment (Germany)

GIG data abundance scale	Adaptation for assessment – first approach –	Adaptation for assessment – second approach –
1	2	1

2 3	3 4	3 5

Table B-3-2 Transformation table for vegetation types (Estonian method)

vegetation type EE	vegetation type GIG data base	assigned EQR value	classification
char, pot, bry	char	1	H
char, pot, bry	pot	0.7	G
batr, cer,pot,nym	cer, pot, nym	0.5	M
cer, nym, nu, lem	cer, nym, nu, lem	0.3	P
absent	no species of types as described above	0	B

Table B-3-3 Transformation table for metric *P. perfoliatus/P. lucens* (Estonian method)

abundance of *P. lucens* and *P. perfoliatus* Estonia	value GIG data base (sum of *P. lucens, P perfoliatus*)	Assigned EQR value	classification
2-4	4-6	1	H
2-4	3	0.7	G
1	2	0.5	M
0-1	1	0.3	P
0	0	0.0	B

Table B-3-4 Transformation table for metric abundance of charophytes (Estonian method)

highest abundance charophytes/mosses/*Fontinalis* Estonia	value GIG data base, sum of charophyte species	assigned EQR value	classification
>3	>=3	1	H
2-3	2	0.7	G
1	1	0.5	M
0	0	0.0	B
0	0	0.0	B

Table B-3-5 Transformation table for metric abundance of some weakly rooting and floating plants (*Ceratophyllum*, lemnids, *Utricularia vulgaris*) (Estonian method)

abudance of weakly rooting plants	value GIG data base (species see above and table)	assigned EQR value	classification
1	2	1	H
1-2	3	0.7	G
3	4	0.5	M
4	5	0.3	P
5	>5	0.0	B

Table B-3-6 Transformation table for metric filamentous algae (Estonian method)

abundance of filamentous algae	value GIG data base (species see	assigned EQR value	classification

Estonia	above and table)		
0	0	1	H
1	1	0.7	G
2	2	0.4	M
3-4	2	0.4	M
5	3	0.0	B

Table B-3-7 Transformation table for metric filamentous algae (Latvian method)

Sum of abundance of indicator species	Quality class
0	B
1	P
2	M
3-5	G
>=6	H

Annex B – Part 4 Relationship of national assessment methods with eutrophication pressure

Table B-4 Overview of Spearman rank correlation coefficients between MSs assessment methods for macrophyte composition and eutrophication parameters (total phosphorus, chlorophyll-a, secchi depth) for LCB1, LCB2 and combined. In addition, the EQR values all compliant MSs are also presented as an averaged value (AVG).

Correlations

			EQR_UK	EQR_NL_15x	EQR_LV	EQR_EE	EQR_BE	EQR_DE	AVG	Chl_mn_v	tp_mn_v	sd_mn_v
Spearman's rho	EQR_UK	Correlation Coefficient	1,000	,325**	,385**	,250**	-,109	,580**	,508**	-,455**	-,418**	,343**
		Sig. (2-tailed)	.	,000	,000	,001	,229	,000	,000	,000	,000	,000
		N	180	180	180	180	123	162	180	144	138	141
	EQR_NL_15x	Correlation Coefficient	,325**	1,000	,761**	,764**	,436**	,007	,857**	-,244**	-,123	,408**
		Sig. (2-tailed)	,000	.	,000	,000	,000	,928	,000	,003	,150	,000
		N	180	180	180	180	123	162	180	144	138	141
	EQR_LV	Correlation Coefficient	,385**	,761**	1,000	,846**	,289**	,251**	,916**	-,519**	-,453**	,646**
		Sig. (2-tailed)	,000	,000	.	,000	,001	,001	,000	,000	,000	,000
		N	180	180	180	180	123	162	180	144	138	141
	EQR_EE	Correlation Coefficient	,250**	,764**	,846**	1,000	,322**	,053	,879**	-,382**	-,329**	,481**
		Sig. (2-tailed)	,001	,000	,000	.	,000	,501	,000	,000	,000	,000
		N	180	180	180	180	123	162	180	144	138	141
	EQR_BE	Correlation Coefficient	-,109	,436**	,289**	,322**	1,000	-,202*	,499**	,022	,104	,139
		Sig. (2-tailed)	,229	,000	,001	,000	.	,036	,000	,831	,325	,181
		N	123	123	123	123	123	109	123	96	91	94
	EQR_DE	Correlation Coefficient	,580**	,007	,251**	,053	-,202*	1,000	,295**	-,409**	-,431**	,325**
		Sig. (2-tailed)	,000	,928	,001	,501	,036	.	,000	,000	,000	,000
		N	162	162	162	162	109	162	162	137	133	135
	AVG	Correlation Coefficient	,508**	,857**	,916**	,879**	,499**	,295**	1,000	-,462**	-,379**	,579**
		Sig. (2-tailed)	,000	,000	,000	,000	,000	,000	.	,000	,000	,000
		N	180	180	180	180	123	162	180	144	138	141
	Chl_mn_v	Correlation Coefficient	-,455**	-,244**	-,519**	-,382**	,022	-,409**	-,462**	1,000	,796**	-,803**
		Sig. (2-tailed)	,000	,003	,000	,000	,831	,000	,000	.	,000	,000
		N	144	144	144	144	96	137	144	144	138	141
	tp_mn_v	Correlation Coefficient	-,418**	-,123	-,453**	-,329**	,104	-,431**	-,379**	,796**	1,000	-,646**
		Sig. (2-tailed)	,000	,150	,000	,000	,325	,000	,000	,000	.	,000
		N	138	138	138	138	91	133	138	138	138	137
	sd_mn_v	Correlation Coefficient	,343**	,408**	,646**	,481**	,139	,325**	,579**	-,803**	-,646**	1,000
		Sig. (2-tailed)	,000	,000	,000	,000	,181	,000	,000	,000	,000	.
		N	141	141	141	141	94	135	141	141	137	141

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

CB 1:

LCB 2:

Correlations

			EQR_UK	EQR_NL_15x	EQR_LV	EQR_EE	EQR_BE	EQR_DE	AVG	Chl_mn_v	tp_mn_v	sd_mn_v
Spearman's rho	EQR_UK	Correlation Coefficient	1,000	,588**	,360**	,225**	,378**	,232**	,587**	-,415**	-,303**	,329**
		Sig. (2-tailed)	.	,000	,000	,002	,000	,001	,000	,000	,000	,000
		N	188	188	188	188	124	188	188	155	151	137
	EQR_NL_15x	Correlation Coefficient	,588**	1,000	,758**	,665**	,686**	,325**	,893**	-,432**	-,166*	,289**
		Sig. (2-tailed)	,000	.	,000	,000	,000	,000	,000	,000	,041	,001
		N	188	189	189	189	124	189	189	155	151	137
	EQR_LV	Correlation Coefficient	,360**	,758**	1,000	,894**	,547**	,581**	,925**	-,539**	-,381**	,456**
		Sig. (2-tailed)	,000	,000	.	,000	,000	,000	,000	,000	,000	,000
		N	188	189	189	189	124	189	189	155	151	137
	EQR_EE	Correlation Coefficient	,225**	,665**	,894**	1,000	,426**	,575**	,853**	-,514**	-,377**	,439**
		Sig. (2-tailed)	,002	,000	,000	.	,000	,000	,000	,000	,000	,000
		N	188	189	189	189	124	189	189	155	151	137
	EQR_BE	Correlation Coefficient	,378**	,686**	,547**	,426**	1,000	,448**	,766**	-,106	-,088	,001
		Sig. (2-tailed)	,000	,000	,000	,000	.	,000	,000	,297	,398	,992
		N	124	124	124	124	124	124	124	98	94	86
	EQR_DE	Correlation Coefficient	,232**	,325**	,581**	,575**	,448**	1,000	,587**	-,381**	-,390**	,415**
		Sig. (2-tailed)	,001	,000	,000	,000	,000	.	,000	,000	,000	,000
		N	188	189	189	189	124	189	189	155	151	137
	AVG	Correlation Coefficient	,587**	,893**	,925**	,853**	,766**	,587**	1,000	-,550**	-,368**	,441**
		Sig. (2-tailed)	,000	,000	,000	,000	,000	,000	.	,000	,000	,000
		N	188	189	189	189	124	189	189	155	151	137
	Chl_mn_v	Correlation Coefficient	-,415**	-,432**	-,539**	-,514**	-,106	-,381**	-,550**	1,000	,654**	-,832**
		Sig. (2-tailed)	,000	,000	,000	,000	,297	,000	,000	.	,000	,000
		N	155	155	155	155	98	155	155	155	151	137
	tp_mn_v	Correlation Coefficient	-,303**	-,166*	-,381**	-,377**	-,088	-,390**	-,368**	,654**	1,000	-,635**
		Sig. (2-tailed)	,000	,041	,000	,000	,398	,000	,000	,000	.	,000
		N	151	151	151	151	94	151	151	151	151	137
	sd_mn_v	Correlation Coefficient	,329**	,289**	,456**	,439**	,001	,415**	,441**	-,832**	-,635**	1,000
		Sig. (2-tailed)	,000	,001	,000	,000	,992	,000	,000	,000	,000	.
		N	137	137	137	137	86	137	137	137	137	137

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

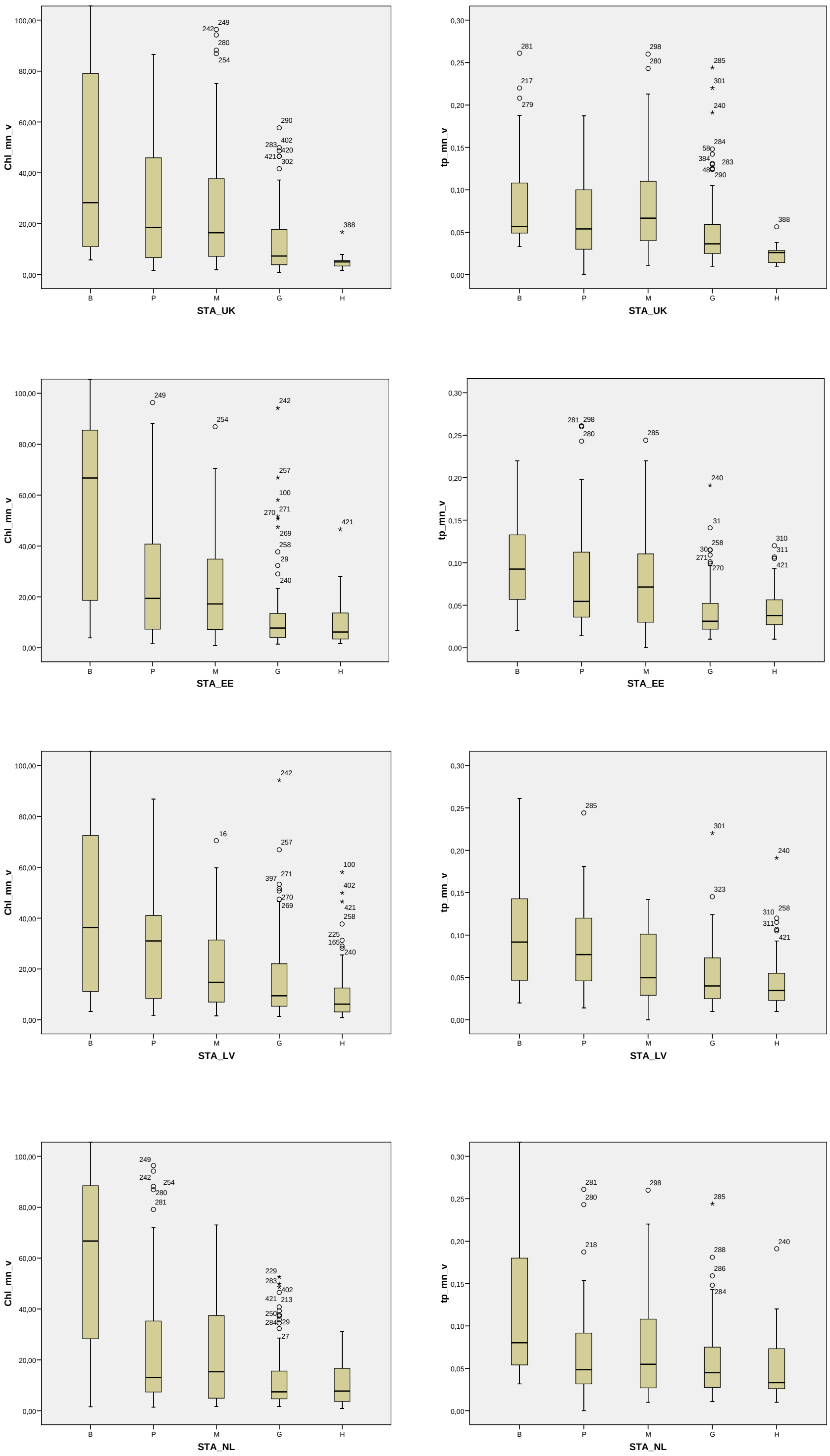
Combined:

Correlations

			EQR_UK	EQR_NL_15x	EQR_LV	EQR_EE	EQR_BE	EQR_DE	AVG	Chl_mn_v	tp_mn_v	sd_mn_v
Spearman's rho	EQR_UK	Correlation Coefficient	1,000	,475**	,375**	,245**	,133*	,364**	,551**	-,440**	-,382**	,354**
		Sig. (2-tailed)	.	,000	,000	,000	,037	,000	,000	,000	,000	,000
		N	368	368	368	368	247	350	368	299	289	278
	EQR_NL_15x	Correlation Coefficient	,475**	1,000	,745**	,683**	,583**	,179**	,872**	-,332**	-,158**	,297**
		Sig. (2-tailed)	,000	.	,000	,000	,000	,001	,000	,000	,007	,000
		N	368	369	369	369	247	351	369	299	289	278
	EQR_LV	Correlation Coefficient	,375**	,745**	1,000	,875**	,444**	,421**	,921**	-,509**	-,421**	,454**
		Sig. (2-tailed)	,000	,000	.	,000	,000	,000	,000	,000	,000	,000
		N	368	369	369	369	247	351	369	299	289	278
	EQR_EE	Correlation Coefficient	,245**	,683**	,875**	1,000	,386**	,310**	,858**	-,445**	-,371**	,408**
		Sig. (2-tailed)	,000	,000	,000	.	,000	,000	,000	,000	,000	,000
		N	368	369	369	369	247	351	369	299	289	278
	EQR_BE	Correlation Coefficient	,133*	,583**	,444**	,386**	1,000	,242**	,662**	-,024	-,010	-,040
		Sig. (2-tailed)	,037	,000	,000	,000	.	,000	,000	,742	,887	,592
		N	247	247	247	247	247	233	247	194	185	180
	EQR_DE	Correlation Coefficient	,364**	,179**	,421**	,310**	,242**	1,000	,441**	-,295**	-,326**	,108
		Sig. (2-tailed)	,000	,001	,000	,000	,000	.	,000	,000	,000	,076
		N	350	351	351	351	233	351	351	292	284	272
	AVG	Correlation Coefficient	,551**	,872**	,921**	,858**	,662**	,441**	1,000	-,488**	-,378**	,428**
		Sig. (2-tailed)	,000	,000	,000	,000	,000	,000	.	,000	,000	,000
		N	368	369	369	369	247	351	369	299	289	278
	Chl_mn_v	Correlation Coefficient	-,440**	-,332**	-,509**	-,445**	-,024	-,295**	-,488**	1,000	,741**	-,797**
		Sig. (2-tailed)	,000	,000	,000	,000	,742	,000	,000	.	,000	,000
		N	299	299	299	299	194	292	299	299	289	278
	tp_mn_v	Correlation Coefficient	-,382**	-,158**	-,421**	-,371**	-,010	-,326**	-,378**	,741**	1,000	-,636**
		Sig. (2-tailed)	,000	,007	,000	,000	,887	,000	,000	,000	.	,000
		N	289	289	289	289	185	284	289	289	289	274
	sd_mn_v	Correlation Coefficient	,354**	,297**	,454**	,408**	-,040	,108	,428**	-,797**	-,636**	1,000
		Sig. (2-tailed)	,000	,000	,000	,000	,592	,076	,000	,000	,000	.
		N	278	278	278	278	180	272	278	278	274	278

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).


Chl_mn_v
STA_UK
tp_mn_v
STA_UK
Chl_mn_v
STA_EE
tp_mn_v
STA_EE
Chl_mn_v
STA_LV
tp_mn_v
STA_LV
Chl_mn_v
STA_NL
tp_mn_v
STA_NL
B
P
M
G
H

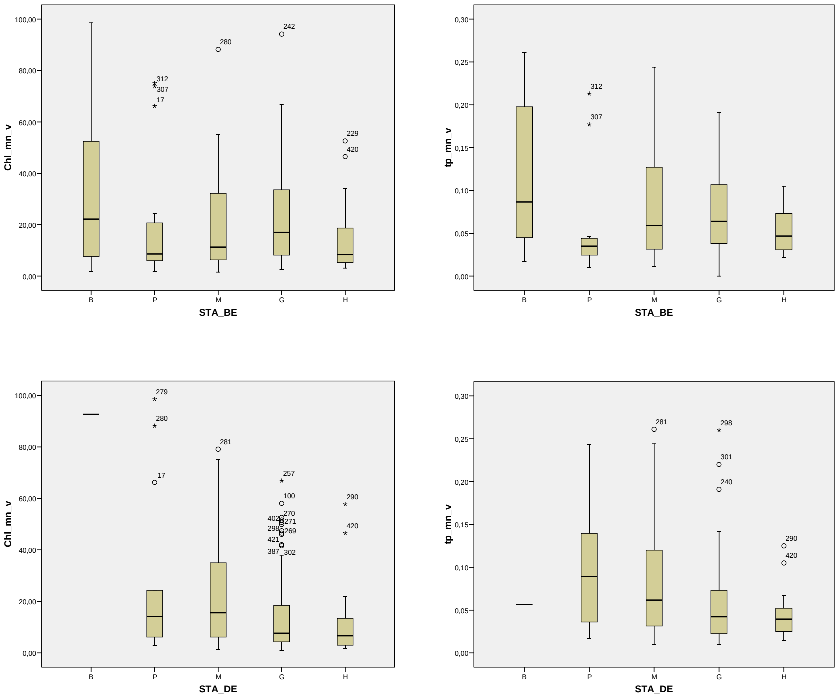


Figure B-4. Box plots of chlorophyll-a (μg) and total phosphorus (mg/l) for different macrophyte composition status classes for each Member State.

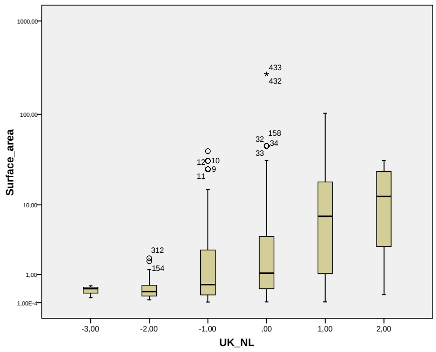
Annex B – Part 5 – Central-Baltic GIG Macrophyte taxa list

Table B-5. The species with their code in the common data base and their frequency in the 426 lake years present in the data base.

Code	Species	Hybrid	Frequency (%)
ALG1ZZZ1	Filamentous algae		8
CAL1COP1	Callitriche cophocarpa		0
CAL1HAM1	Callitriche hamulata Kutz ex W.D.J. Koch		1
CAL1HER1	Callitriche hermaphroditica L.		2
CAL1PAL1	Callitriche palustris L.		1
CAL1STA1	Callitriche stagnalis Scop.		1
CER1DEM1	Ceratophyllum demersum L.		38
CHA1ASP1	Chara aspera Deth. Ex Wild.		15
CHA1BAL1	Chara baltica Bruzelius		0
CHA1CON1	Chara connivens SALZM.		6
CHA1CON2	Chara contraria A. Br.		21
CHA1DEL1	Chara delicatula Ag.		7
CHA1FIL1	Chara filiformis		1
CHA1FRA1	Chara fragilis Desvaux		2
CHA1GLO1	Chara globularis Thuill.		22
CHA1HIS1	Chara hispida L.		7
CHA1INT1	Chara intermedia A. Braun		1
CHA1RUD1	Chara rudis		3
CHA1STR1	Chara strigosa A. Braun		0
CHA1TOM1	Chara tomentosa L.		9
CHA1VUL1	Chara vulgaris L.		10
CHA1ZZZ1	Chara sp. L. ex Vaillant		22
CHA2ZZZ1	Charophyta		20
CRA2AQU1	Crassula aquatica		0
ELA1HEX1	Elatine hexandra (Lapierre) DC		2
ELA1HYD1	Elatine hydropiper L.		0
ELA1ORT1	Elatine orthosperma Duben		0
ELA1TRI1	Elatine triandra Schkuhr		0
ELE1ACI1	Eleocharis acicularis (L) Roem et Schult		6
ELO1CAN1	Elodea canadensis Michx.		28
ELO1NUT1	Elodea nuttallii (Planch.) H. St. John		18
HYD1VER1	Hydrilla verticillata L.		1
HYD2MOR1	Hydrocharis morsus-ranae L.		17
ISO1ECH1	Isoetes echinospora Durieu		0
ISO1LAC1	Isoetes lacustris L.		5
LEM1GIB1	Lemna gibba L.		3
LEM1MIN1	Lemna minor L.		19
LEM1TRI1	Lemna trisulca L.		15
LIM1AQU1	Limosella aquatica		0
LIT1UNI1	Littorella uniflora (L.) Ascherson		2
LOB1DOR1	Lobelia dortmanna L.		2
MYR1ALT1	Myriophyllum alterniflorum DC.		6
MYR1SIB1	Myriophyllum sibiricum		0
MYR1SPI1	Myriophyllum spicatum L.		42
MYR1VER2	Myriophyllum verticillatum L.		13
NAJ1FLE1	Najas flexilis (Willd.) Rostk. & W.L.E. Schmidt		1
NAJ1MAR1	Najas marina L.		12
NAJ1TEN1	Najas tenuissima (A. Braun) Magnus		1
NIT1CON1	Nitella confervacea (Bréb.) A. Braun		0
NIT1FLE1	Nitella flexilis (L.) Ag.		7
NIT1MUC1	Nitella mucronata (A. Br.) Miquel		4
NIT1OPA1	Nitella opaca Ag.		3
NIT1TRA1	Nitella translucens (Pers.) Ag.		1
NIT1WAH1	Nitella wahlbergiana		0
NIT2OBT1	Nitellopsis obtusa (Desv.) J. Groves		18
NUP1LUT1	Nuphar lutea (L.) Sibth. & Sm.		57

NUP1PUM1	Nuphar pumila (Timm) DC.	lutea x pumila	8
NUP1SPE1	Nuphar x spenneriana Gaudin		1
NYM1ALB1	Nymphaea alba L.	candida x tetragona	23
NYM1ALX1	Nymphaea candida x tetragona		1
NYM1CAN1	Nymphaea candida Presl		17
NYM1TET1	Nymphaea tetragona Georgi.	alba x candida	0
NYM1XAL1	Nymphaea alba x candida		2
NYM2PEL1	Nymphoides peltata (S. G. Gmelin) O. Kuntze		7
PER1AMP1	Persicaria amphibia (L.) Gray		14
POT1ACU1	Potamogeton acutifolius Link		3
POT1ALP1	Potamogeton alpinus Balbis		3
POT1BER1	Potamogeton berchtoldii Fieber		3
POT1COM1	Potamogeton compressus L.		6
POT1CRI1	Potamogeton crispus L.		18
POT1FIL1	Potamogeton filiformis Pers.		3
POT1FRI1	Potamogeton friesii Rupr.		8
POT1GRA1	Potamogeton gramineus L.		7
POT1LUC1	Potamogeton lucens L.		33
POT1NAT1	Potamogeton natans L.		42
POT1OBT1	Potamogeton obtusifolius Mert. & Koch		7
POT1PEC1	Potamogeton pectinatus L.		46
POT1PER1	Potamogeton perfoliatus L.		52
POT1POL1	Potamogeton polygonifolius Pourret		1
POT1PRA1	Potamogeton praelongus Wulfen		9
POT1PUS1	Potamogeton pusillus L.		24
POT1RUT1	Potamogeton rutilus Wolfg.		2
POT1TRI1	Potamogeton trichoides Cham. & Schltdl		4
POT1VAG1	Potamogeton vaginatus Turcz.	gramineus x perfoliatus	0
POT1XGR2	Potamogeton x nitens Weber	gramineus x natans	1
POT1XSP1	Potamogeton x sparganiifolius Laestad ex Fries	filiformis x pectinatus	0
POT1XSU2	Potamogeton x suecicus K. Richt.	gramineus x lucens	0
POT1XZI1	Potamogeton x zizii		1
RAN1AQU1	Ranunculus aquatilis L.		8
RAN1CIR1	Ranunculus circinatus Sibth		15
RAN1CON1	Ranunculus confervoides		1
RAN1PEL1	Ranunculus peltatus Schrank.		1
RAN1REP2	Ranunculus reptans		0
SAG1NAT1	Sagittaria natans		0
SAG1XSA1	Sagittaria sagittifolia x natans		1
SPA1ANG1	Sparganium angustifolium		1
SPA1GRA1	Sparganium gramineum	angustifolium x gramineum	0
SPA1HYP1	Sparganium hyperboreum		0
SPA1NAT1	Sparganium natans		0
SPA1XAN1	Sparganium angustifolium x gramineum		1
SPI1POL1	Spirodela polyrhiza (L.) Schleid		9
STR1ALO1	Stratiotes aloides L.		10
SUB1AQU1	Subularia aquatica L.		1
TOL1CAN1	Tolypella canadensis		0
TOL1GLO1	Tolypella glomerata		2
TRA1NAT1	Trapa natans L.		0
UTR1AUS1	Utricularia australis Thor		1
UTR1INT1	Utricularia intermedia Hayne		1
UTR1MIN1	Utricularia minor L.		2
UTR1OCH1	Utricularia ochroleuca R. Hartman		0
UTR1VUL1	Utricularia vulgaris L.		16
UTR1ZZZ1	Utricularia		8
ZAN1PAL1	Zannichellia palustris L.		22
CER1_SUB1	Ceratophyllum submersum Bisch.		0
SPA1_ERE1	Sparganium erectum L.		1
NIT1_SYN1	Nitella syncarpa (Thuillier) Chevalier		0

Annex B – Part 6 – Comparison of NL and UK assessment systems



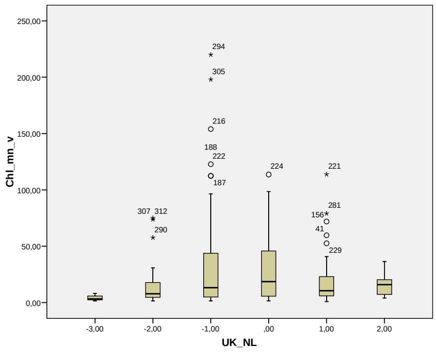


Fig. B-6. Box plots of surface area and chlorophyll-a values of lakes for different class deviations between UK and NL. The upper figure shows that the Dutch macrophyte assessment method is relatively precautionary in small lakes (surface area in km^2) but relatively less precautionary in large lakes as compared to the UK assessment method.

Annex B – Part 7 – Intercalibration Option 3 results for LakeCentral Baltic GIG macrophyte assessment methods

Table B-7. Intercalibration Option 3 results for LakeCentral Baltic GIG macrophyte assessment methods. DC=0 – the fraction of comparison with zero class difference; |DC|<=1 the fraction of comparison with at most one class difference;WA – weighed average class difference of all comparisons, ABS(AW) – average absolute class difference of all comparisons, n – number of comparisons.

LCB1		EE	LV	PL	UK	NL	BE	DE	avg
		LCB1	LCB1	LCB1	LCB1	LCB1	LCB1	LCB1	
FIVE CLASSES	DC=0	0.39	0.31	0.38	0.32	0.37	0.24	0.37	0.34
	|DC|<=1	0.85	0.76	0.89	0.78	0.89	0.72	0.82	0.82
	WA	-0.07	-0.03	0.32	-0.08	-0.14	0.29	0.10	0.06
	ABS(WA)	0.79	0.97	0.77	0.93	0.74	1.09	0.83	0.88
	n	822	822	53	822	822	602	711	
FIVE CLASSES. stretched boundaries	DC=0	0.65	0.57	0.70	0.62	0.67	0.55	0.64	0.63

	|DC|<=1	0.93	0.87	0.91	0.90	0.97	0.86	0.92	0.91
	WA	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
	ABS(WA)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
	n	819	821	53	821	821	602	711	
THREE CLASSES	DC=0	0.58	0.56	0.38	0.51	0.59	0.43	0.51	0.51
	|DC|<=1	0.94	0.92	0.96	0.94	0.96	0.93	0.93	0.94
	WA	-0.02	0.26	0.21	-0.11	-0.21	0.23	-0.12	0.03
	ABS(WA)	0.47	0.52	0.66	0.55	0.44	0.64	0.56	0.55
	n	822	822	53	822	822	602	711	
THREE CLASSES. stretched boundaries	DC=0	0.76	0.76	0.57	0.70	0.76	0.73	0.70	0.71
	|DC|<=1	0.98	0.98	0.98	0.98	0.99	0.98	1.00	0.98
	WA	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
	ABS(WA)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
	n	822	822	53	822	822	602	711	
LCB2		EE	LV	PL	UK	NL	BE	DE	avg
		LCB2	LCB2	LCB2	LCB2	LCB2	LCB2	LCB2	
FIVE CLASSES	DC=0	0.33	0.35		0.31	0.36	0.35	0.34	0.34
	|DC|<=1	0.79	0.75		0.77	0.85	0.81	0.81	0.80
	WA	-0.27	-0.02		-0.11	-0.12	0.31	0.37	0.03
	ABS(WA)	0.92	0.96		0.97	0.81	0.87	0.89	0.90
	n	827	827	0	825	827	600	652	
FIVE CLASSES. stretched boundaries	DC=0	0.58	0.58		0.53	0.63	0.60	0.62	0.59
	|DC|<=1	0.90	0.85		0.88	0.93	0.91	0.89	0.89
	WA	n.a.	n.a.		n.a.	n.a.	n.a.	n.a.	
	ABS(WA)	n.a.	n.a.		n.a.	n.a.	n.a.	n.a.	
	n	827	827	0	825	827	600	652	
THREE CLASSES	DC=0	0.57	0.57		0.51	0.56	0.53	0.49	0.54
	|DC|<=1	0.94	0.92		0.90	0.95	0.93	0.93	0.93
	WA	-0.10	0.29		-0.24	-0.11	0.10	0.11	0.01
	ABS(WA)	0.49	0.51		0.59	0.48	0.55	0.57	0.53
	n	827	827	0	825	827	600	652	
THREE CLASSES. stretched boundaries	DC=0	0.76	0.75		0.67	0.75	0.70	0.72	0.72
	|DC|<=1	0.98	0.98		0.95	0.98	0.98	0.97	0.97
	WA	n.a.	n.a.		n.a.	n.a.	n.a.	n.a.	
	ABS(WA)	n.a.	n.a.		n.a.	n.a.	n.a.	n.a.	
	n	827	827	0	825	827	600	652	

Annex B – Part 8 – Comparison of Option 2 and 3 methodologies

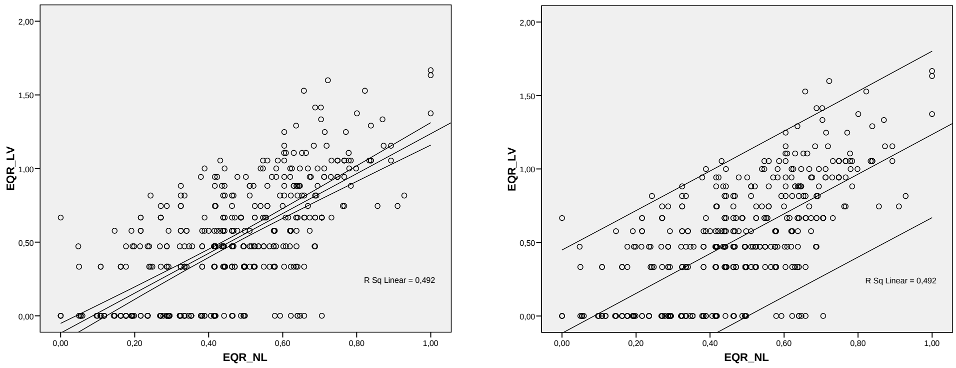


Fig. B-8-1. The Dutch EQR (independent) versus the Latvian EQR (dependent) with confidence 95% confidence intervals for the regression line (left) and with 95% confidence intervals for individual classifications (right). *The left methodology is used for estimating confidence in boundaries in option 2 though with an additional step namely the common metric. while the right methodology for estimating confidence is most similar to the approach as used in our option 3. Note that using individual based confidence intervals result in much higher uncertainty than the prediction of the regression.*

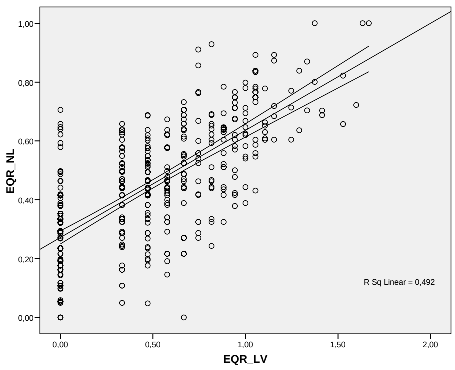


Fig. B-8-2. The Latvian EQR (independent) versus the Dutch EQR (dependent) with confidence 95% confidence intervals for the regression line. *Note that this type I regression is very sensitive for choice which metric is dependent and which metric in independent. Comparing the Latvian eqr=1 with the Dutch in this figure and the upper left figure result in one quality class difference.*

Macrophyte ANNEXES

Annex C – Northern GIG

Content

Part 1 -Development of NGIG common metric
Part 2 - Description of national methods included in the intercalibration
Part 3 - Reference criteria
Part 4 - Reference sites
Part 5 - Development of a site-specific predictive model for reference ICCM
Part 6 – Reference conditions for the common metric (ICCM)
Part 7 - Relationship between impact indicators (total phosphorus, chlorophyll a and Secchi depth) and macrophyte status
Part 8 - Intercalibration of the water quality element of macrophytes – a comparison between Sweden and the N-GIG
Part 9 Varying geographical and climatic conditions within the Northern GIG

Annex C – Part 1 -Development of NGIG common metric

A common metric to detect nutrient enrichment pressures in NGIG lakes using macrophytes was developed for use in intercalibration. The metric combines compositional information linked to a ranking of species based on their association with lakes of differing fertility (expressed as annual mean water column TP) in order to derive a site index.

Species rankings were constructed using information on TP optima and sample size calculated for each macrophyte in their national dataset by each NGIG MS. Data was provided for 196 species of which 153 had a global sample size >5. In the case of 57 species the global sample size exceeded 100.

This data was consolidated after removing synonyms and a single value for each species was then calculated based on a weight of evidence approach. This required taking the mean value across countries providing data for that species, weighted by the number of samples from each country. Total phosphorus values were converted to a log scale and rescaled to a range running from 1 (*Drepanocladus trichophyllus*) -10 (*Callitriche platycarpa*). In the case of rare taxa, including those with large disagreement between countries, or those in the common dataset with no supporting TP, an algorithmic method within Canonical Correspondence Analysis was used to generate scores using information from species for which sufficient data were available.

Based on information from 35 wide ranging taxa with TP values submitted by four or more countries, there is a generally a high precision in the supplied values with an average standard per taxa error equivalent to 21% of the global mean (see Figure C-1).

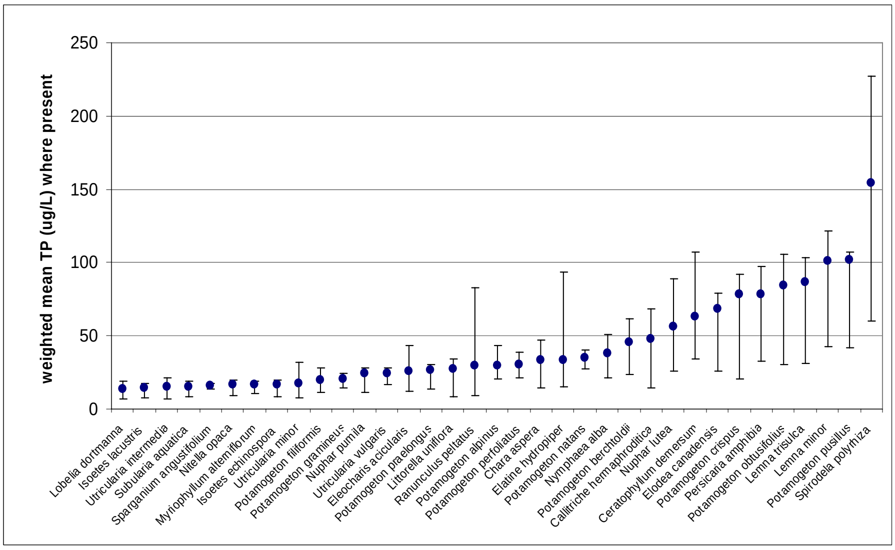


Fig. C-1. Weighted mean TP values of 35 wide-ranging taxa in the NGIG dataset. Bars illustrate maxima and minima of optima values submitted for that species by all countries**.**

The ICCM value for a site is calculated based on presence-absence survey data (the common minimum standard) and, to maintain consistency, must be applied to a common minimum list of species. Given this requirement the index was confined to obligate vascular hydrophytes plus charophytes (=scoring species) while all helophytes, facultative helophytes, and aquatic bryophytes were excluded. Therefore the ICCM is calculated as the average of the index values of the scoring taxa.

Evaluation of the ICCM (Figure C-2) indicates that it is closely correlated with average TP values in the NGIG common dataset (typically performing at or above the standard of national metrics in this respect). While this should not be construed as a cause-effect relationship it confirms a necessary association between the metric and the pressure on which the GIG is intercalibrating.

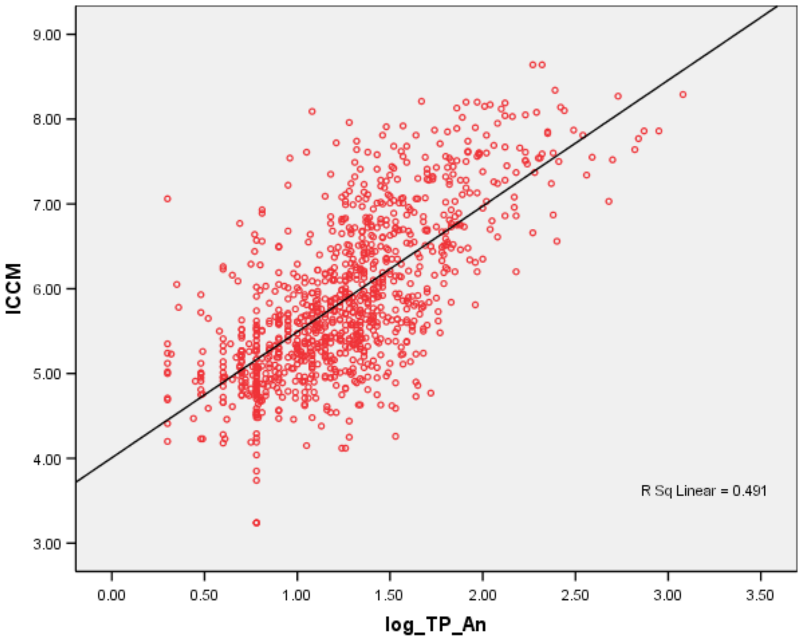


Figure C - 2. Relationship between lake ICCM and mean TP concentrations in the global NGIG dataset (n=1074 surveys).

Annex C – Part 2 Description of national methods included in the intercalibration

2.1. Finnish system of macrophyte classification

Finnish preliminary system of macrophyte classification is based on recent report of Leka et al. (2007), where a large dataset consisting of 773 lakes and ponds was analysed. One of the major finding showed a strong latitudinal difference in species composition showed also old study of Linkola (1933) and recent study of Heino & Toivonen (2007). This means that distributional patterns are very significant when classification system is established and different types are formed. Leka et al. (2007) proposed to use several indices based both on species composition and abundance as well as traditional share of indicator species such as eutrophy indicators. One tested indicator was type-specific species, which is based on the method developed by Hämäläinen et al. (2002) for benthic invertebrates of rivers. In principle it follows general determination of WFD, where type specific communities of macrophytes are emphasized. Basic assumption is that typical, type specific species are present in 50 % of reference lakes of each type.

The presence of type specific species is calculated as follows. The probability of occurrence (p) for each species (i) in any reference lakes (j) belonging to each lake type (k) is first estimated as

$$P_{kj*1} = \frac{\sum kji}{\sum kj}$$

i.e. the ratio between the number of reference sites of the type k occupied by the species i and the total number of reference sites belonging to that type. Species with $P_{kj*1} \geq 0.5$ are considered to be type-specific. The observed number of type-specific species in each lake (j) belonging to a type k is obtained simply as

$$O_{kij} = \sum kji \big| p_{kj*i} \geq 0.5$$

Method is proved to be efficient for benthic invertebrates, but for macrophytes the interpretation is difficult because of a large number of generalist species (Vallinkoski et al. 2004). The index does not take into account the new species arriving with the course of eutrophication. Therefore more advanced index, share of type-specific species of total number of species (S_{ts}), was developed.

All species were notified in species richness, so the share of type specific species in a reference lake was:

$$Sts = \frac{\sum kji}{\sum kji \big| p_{kj*i} \geq 0.5}$$

In other words type specific (reference) species are replaced by other species indicating eutrophication, for example typical soft water isoetids communities are replaced by nymphaeids or lemnids, which are usually rich in biodiversity.

First trials in small lakes of central Finland showed that this index is decreasing with increasing eutrophication (Vallinkoski et al. 2004). Later it was applied to historical dataset, where it showed to be one of the most efficient (Leka et al. 2007).

Finnish recent lake typology is mainly based on lake size, humic content and mean depth with specific types of naturally nutrient rich and northern Lapland lakes. Due to strong latitudinal gradient of species richness most of the lake types are divided to northern and southern ones.

As an example of typology, large lakes (size > 40 km^2) with water colour less than 30 $mgPtl^{-1}$ from southern part (excluding Lapland) have following typical species with frequency more than 50 % (8 lakes in database).

Alisma plantago-aquatica
Calla palustris
Carex lasiocarpa
Carex rostrata
Eleocharis acicularis
Eleocharis palustris
Equisetum fluviatile
Isoëtes echinospora
Isoëtes lacustris
Juncus supinus
Lobelia dortmanna
Lysimachia thyrsiflora
Myriophyllum alterniflorum
Nuphar lutea
Nymphaea alba ssp_ candida
Phragmites australis
Potamogeton natans
Potentilla palustris
Ranunculus peltatus
Ranunculus reptans
Schoenoplectus lacustris
Sparganium angustifolium
Sparganium gramineum
Subularia aquatica
Warnstorfia procera

Note that also helophytes are included. Expected share of type specific species of total number of species varies theoretically between 1 and 0. Below is a plot between totP and S_{ts} in large southern clear water lakes (Fig C-2-1)

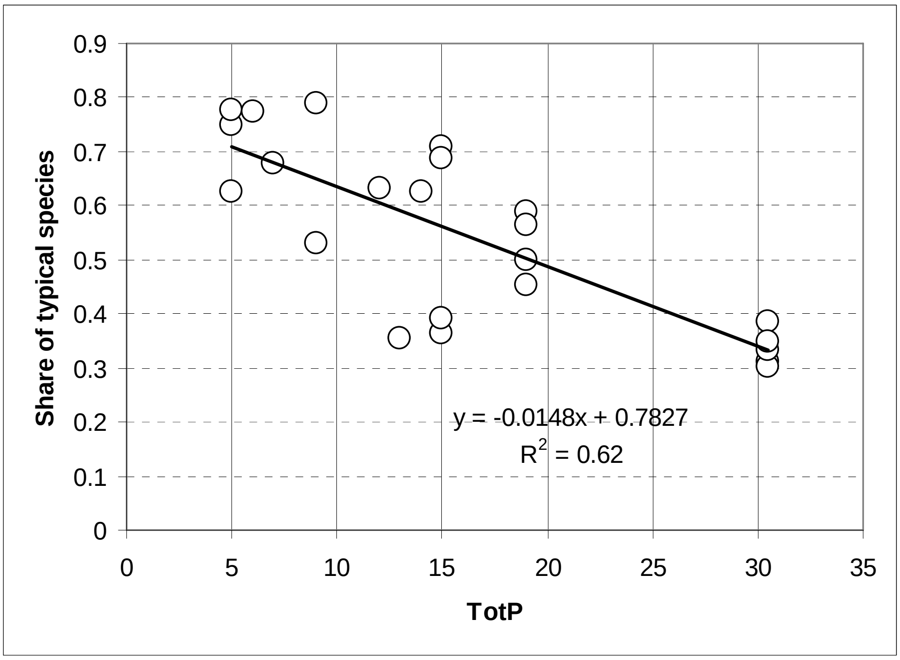


Fig C-2-1. Relationship between Total phosphorus (TP) concentration and Share of typical species in large southern clear water lakes of Finland.

According to latest instructions for lake typology and classification (SYKE 2007), index is transferred to EQR values by following way:

- Reference value = upper quartile of index of reference lakes (of different types)
- Boundary between high and good status = lower quartile of reference lakes index
- Other boundaries are divided evenly between H/G and B, assumption is that response to relatively short gradient of phosphorous is linear.

2.2. The Swedish method for Macrophytes in lakes

The Swedish trophic index is based on the response of macrophytes (Characeae, mosses and vascular plants except helophytes) along a Tot-P gradient. The trophic index is a weighted average of all species' indicator values in a lake. The indicator value is based on the median of the Tot-P concentration of all lakes, the respective macrophyte species occurs in. The weighting factor is based on the range of the 25 and 75 percentiles of the median. Class boundaries were determined with classification trees using Tot-P values of species typical for the different classes of ecological status. The species used for classification were those showing sudden drops in their occurrence beyond the 75% percentile.

Reference lakes

For the development of a typology, only data from reference lakes were analyzed. Reference lakes were lakes that fulfilled the following requirements:

1. Percentage area of clear-cuts within the lakes' catchment area: <10%
2. Percentage area of agricultural lakes within the lakes' catchment area: <10%
3. Percentage area of urban area within the lakes' catchment area: <0.1%
4. Unaffected by lowering of water level
5. pH >6.0
6. Tot-P concentrations <12.5 µg l^{-1}
7. Tot-N concentrations <300 µg l^{-1}

Lakes with historical data (>65 yr old) were considered as reference lakes if the prerequisites 4-7 were fulfilled. Further lakes were included as reference lakes that met prerequisites 1-4, lacked information for one of the prerequisites 5-7 but met the criteria for two of the remaining prerequisites 5-7.

Typology types

The development of a typology was then performed in two steps: 1. Search for typology types based on macrophyte data, only. 2. Identification of environmental or geographical factors that discriminate between the typology types from step 1.

In step 1, only macrophyte species (including helophytes) with occurrence in at least three lakes were included in the analyses. Tree clustering with Ward's method based on an Euclidean distance matrix was used to identify typology types. Discrimination among the typology types was performed with discriminate analysis in combination with Kruskal Wallis test and Mann-Whitney U-test, using the following typology variables: X- and Y-coordinate, altitude, lake area, Secchi depth, water temperature, conductivity and Ca-concentration. The final typology model included three typology groups that were significantly discriminated from each other based on geographical position and altitude, only:

Type 1: N of *Limes Norrlandicus*, above the highest coastline
Type 2: N of *Limes Norrlandicus*, below the highest coastline
Type 3: S of *Limes Norrlandicus*, below the highest coastline

Indicator values

For each macrophyte species (excluding helophytes), an indicator value was developed based on the response (median Tot-P concentration) of the species along a gradient of Tot-P concentration (Figure ***C-2-2a***). Indicator values were calculated for macrophyte species that occurred in at least three lakes. The Tot-P concentration gradient was divided into 10 intervals (1-10) of which each interval equals an indicator value (Table ***C-2-2a***). An indicator value of 10 indicates that a macrophyte species occurs in lakes with Tot-P concentrations <10 µg l^{-1}. Considering the tolerance of each species along the Tot-P concentration gradient, i.e. each species niche breadth, each species was assigned a weighting factor (Table ***C-2-2b***).

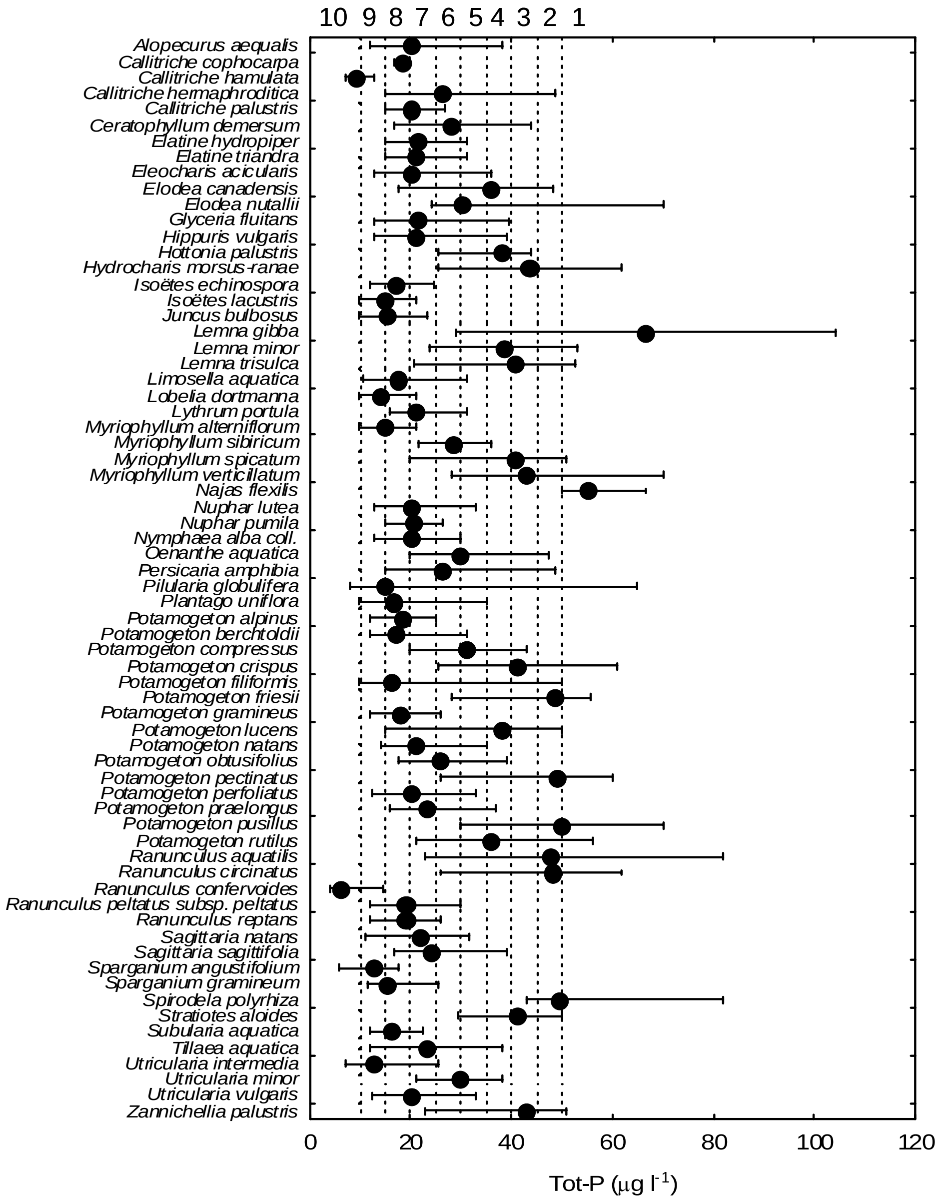


Figure C-2-2a. Macrophyte preferences (median ± 25 and 75 percentiles) and indicator values (top) along the Tot-P concentration gradient. Only vascular hydrophytes (in alphabetic order) are shown. The analyses included species that occurred in ≥3 lakes.

Table C-2-2a. Macrophyte indicator values along the Tot-P concentration gradient. Macrophytes were assigned the indicator value where the species had its preference (median Tot-P).

Indicator value	Tot-P (µg l^{-1})
10	≤ 10
9	> 10 – ≤ 15

8	> 15 – ≤ 20
7	> 20 – ≤ 25
6	> 25 – ≤ 30
5	> 30 – ≤ 35
4	> 35 – ≤ 40
3	> 40 – ≤ 45
2	> 45 – ≤ 50
1	> 50

Table *C-2-2b*. Weighting factors for calculating the trophic macrophyte index (TMI). Weighting based on the difference between the 75 and 25 percentiles of the species' preferences (median) along the Tot-P gradient.

Weighting factor	$75_{perc} - 25_{perc}$
	Tot-P (µg l^{-1})
1.0	≤ 10
0.9	> 10 – ≤ 20
0.8	> 20 – ≤ 30
0.7	> 30 – ≤ 40
0.6	> 40 – ≤ 50
0.5	> 50 – ≤ 60
0.4	> 60 – ≤ 70
0.3	> 70 – ≤ 80
0.2	> 80 – ≤ 90
0.1	> 90

Trophic index

The trophic macrophyte index (TMI) based on macrophyte occurrence can be calculated for each lake based on a species list as well as indicator and weighting values for each species according to

$$\mathrm{TMI}_{\mathrm{Lake}_x} = \frac{\sum_{i=1}^{n}(\text{Indicator value}_{\text{Species}_i} \times \text{Wei}}{\sum_{i=1}^{n}\text{Weighting facto}} \quad \textit{Equation 1}$$

Reference values and EQRs

The trophic macrophyte indices of reference lakes were used to define high ecological status. The ratio between the median TMI and the TMI 75 percentiles defined the H/G boundary. The boundaries were calculated separately for each typology type. Boundaries between the classes of lower ecological status were defined by Tot-P concentrations that were preferred by species that were regarded as representative for the respective classes of ecological status.

As a first step, species of high, god and low ecological status, respectively, were selected based on their indicator values and weighting factors (Table 1, 2). High status species were *Scorpidium scorpioides Warnstorfia fluitans*, *W. trichophylla*, *Nitella opaca*, *Callitriche hamulata* and *Ranunculus confervoides*. God status species were *Isoëtes lacustris*, *Limosella aquatica*, *Lobelia dortmanna* and *Plantago uniflora*. Low status species (indicating P or B) included *Ricciocarpus natans* and *Spirodela polyrhiza*.

In the second step, lakes were classified as high/good, good, low and indifferent lakes, respectively, based on the occurrence of the species above. High/good lakes were lakes where only high or god status species occurred. In lakes of the good status group, only species indicating good status occurred. In low status lakes only low status species occurred. The Tot-P concentrations of high/good status lakes and low status lakes were in classification trees used to discriminate between lakes of good and moderate ecological status (Figure ***C-2-2b***). Correspondingly, Tot-P concentrations of good status lakes and low status lakes were in classification trees used to discriminate between lakes of moderate and poor ecological status. The tot-P boundary values were translated to TMI using the regression equations between tot-P and TMI for typology type 1-3, respectively. The boundary for G/M was calculated as 23.25 µg Tot-P l^{-1} and for M/P as 40 µg Tot-P l^{-1}.

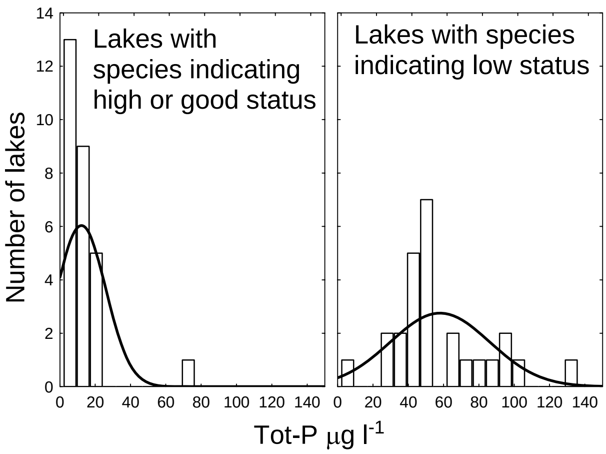


Figure C-2-2b. Frequency distribution of Tot-P in lakes with only species indicating high or good status (left) and lakes with only species indicating low ecological status (right). Using classification trees and the two species groups, the class boundary G/M was calculated as 23.25 µg Tot-P l^{-1}.

For each typology type, EQRs were calculated according to

$$EQR_{Lake_x} = \frac{(Observed\ TMI_{\ Lake_x} - Minimum\ TMI)}{(Reference\ value - Minimum\ TMI)} \qquad Equation\ 2$$

The minimum TMI = 1 (the lowest indicator value). Equation 2 was used to calculate the G/M and M/P boundaries (Table ***C-2-2c***.). The observed TMI for calculating the class boundaries is the with tot-P values calculated TMI boundary between the G/M and M/P lakes, respectively (see above).

In case the EQR of a lake is 0.05 units from the class boundary, a species list with typical species for respective class of ecological status is used for expert judgment.

Table C-2-2c. EQRs for TMI divided by typology group. Data were not available to calculate the P/B boundary.

Typology group	Class boundary		
	H/G	G/M	M/P
1	0,97	0,90	0,83
2	0,97	0,94	0,85
3	0,98	0,88	0,58

2.3. Norwegian macrophyte assessment system

For Norway, preliminary trophic indices have been reported in Mjelde (2007). The indices use both presence/absence and semi-quantitative data. The macrophyte species are categorised as sensitive, tolerant or indifferent to eutrophication.

The Norwegian macrophytes in lakes are collected by a boat survey around the lake, which produce species lists with semi-quantitative scores.

We have developed two similar trophic indicies, TI(count) and TI(abundance). Both indicies are based on a previously defined classification of species by percentiles, where the species are grouped as sensitive, tolerant or indifferent to eutrophication. The indices subtract the number or abundance of tolerant species from the number or abundance of sensitive species.

The index used in the Intercalibration is the TI(count). This is based on the count of species, and presence/absence data only is sufficient:

$TI_{count} = \frac{N_S - N_T}{N} \times 100$, where N_S is the number of sensitive species found in the lake, N_T is the number of tolerant species, and N is the total number of species, including indifferent species. The indices produce a number between +100, where all species are defined as sensitive, and -100, where all species are tolerant, for each lake.

All aquatic macrophyte life form groups (isoetids, elodeids, nymphaeids, lemnids, and charophytes) are included.

The TI (count) seems to correlate well with total P for all Norwegian lakes (r^2 = 0,69).

For use in boundary settings we have suggested the change in appearance and abundance of the large isoetids *Isoetes lacustris*, *I. echinospora*, *Littorella uniflora* and *Lobelia dortmanna* in low alkaline lakes and *Chara* spp. in high alkaline lakes. The boundary good/moderate represents the situation where stands of large isoetids (in low-moderate alkaline lakes) and *Chara* spp. (in high alkaline lakes) disappeared (“sudden drop”), however, patchy and scattered abundance can still be observed. The high/good boundary is very preliminary set as the ratio between median and 75 perc of reference lake index values. The boundary settings are not completed and will be further tested and discussed.

The Trophic Indices can not be used when low species number (i.e. < 4-5), or missing macrophyte vegetation. In such cases, additional indices are needed. The indices seem useful for most moderate-high alkalinity lakes. Especially for the very low and low alkalinity lakes we have too few data or too short P gradient for proper development of the indices.

Table C-2-3. List of Norwegian aquatic macrophytes in lakes - sensitive, tolerant or indifferent to eutrophication. Species with < 4 loc. in brackets. (S,I): changed from sensitive or indifferent species based on PCA diagrams.

group	Sensitive species	Tolerant species	Indifferent species
ISOETIDS	*Crassula aquatica* *Elatine hydropiper* *(Elatine orthosperma)* *Eleocharis acicularis* *Isoëtes echinospora* *Isoëtes lacustris* *Limosella aquatica* *Littorella uniflora* *Lobelia dortmanna* *Lythrum portula* *Ranunculus reptans* *Subularia aquatica*	*(Elatine hexandra)* *Elatine triandra*	
ELODEIDS	*Callitriche hamulata* *Callitriche hermaphroditica* *Callitriche palustris* *Hippuris vulgaris* *Juncus bulbosus* *Myriophyllum alterniflorum* *Myriophyllum sibiricum* *(Najas marina)* *(Potamogeton compressus)* *Potamogeton filiformis* *(Potamogeton friesii x obtusifolius)* *Potamogeton gramineus* *Potamogeton x nitens* *Potamogeton polygonifolius* *Potamogeton praelongus* *(Potamogeton vaginatus)* *(Potamogeton x sparganifolius)* *Ranunculus confervoides* *Ranunculus peltatus* *Utricularia intermedia* *Utricularia minor* *Utricularia ochroleuca*	*Callitriche cophocarpa* *Callitriche stagnalis* *Ceratophyllum demersum* *Elodea canadensis* **(I)** *Myriophyllum spicatum* *Myriophyllum verticillatum* *(Najas flexilis)* *Potamogeton crispus* *Potamogeton friesii* *Potamogeton lucens* **(S)** *Potamogeton obtusifolius* *Potamogeton pectinatus* *Potamogeton pusillus* *Potamogeton rutilus* *(Potamogeton x zizii)* *(Potamogeton x suecicus)* *Ranunculus aquatilis* *(Zannichellia palustris)*	*Potamogeton alpinus* *Potamogeton berchtoldii* *Potamogeton perfoliatus* *Utricularia vulgaris* **(S)**
NYMPHAEIDS	*(Luronium natans)* *Nuphar pumila* *Sparganium angustifolium* *(Sparganium gramineum)* *Sparganium hyperboreum* *Sparganium natans*	*Persicaria amphibia* *Sparganium emersum*	*Nuphar lutea* *Nymphaea alba* coll. *Potamogeton natans* *Sagittaria sagittifolia*
LEMNIDS		*Lemna minor* *Lemna trisulca* *(Ricciocarpus natans)* *Spirodela polyrrhiza*	
CHARIDS	*Chara aspera* *(Chara braunii)*	*(Chara intermedia)* *(Chara tomentosa)*	

	Chara contraria *Chara delicatula* *Chara globularis* *Chara rudis* *Chara strigosa* *(Nitella batrachosperma)* *(Nitella mucronata)* *Nitella opaca* *Tolypella canadensis*		

2.4. UK LEAFPACS macrophyte assessment methods

For UK, the LEAFPACS method has been developed by Nigel Willby (Stirling University). The method is currently being evaluated, but is likely to become the nationally accepted method if the intercalibration process is completed and the method is shown to compare successfully in both the NGIG and the CGIG. A summary documentation of method in preparation, full report will be available in summer of 2007
A summary of the LEAFPACs method (Draft 6 June 2007) is provided below, further details are available in Annex A of CGIG macrophyte report.

Status: Proposed national method which it is expected will be accepted for use in UK during the summer of 2007. (Refers only to macrophyte components, not phytobenthos)

Which indicators are used?

Macrophyte taxonomic composition:
The taxonomic composition of hydrophytes (including angiosperms, hepaticae, charophytes and bryophytes) is normally assessed at species level although there are some exceptions. The hydrophytes are assigned to one of 18 functional groups defined by a range of morphological characteristics. A species list with associated index values and functional group categories is supplied in Appendix 1 at the end of this document.

Macrophyte abundance:
Abundance is expressed as percentage cover of the area of the lake that is colonised, rather than as a percentage of the whole lake area. Data from a set of discrete sampling units are combined, and converted into a valid measure of the cover of different species at a site scale. There are two basic sampling units, a shoreline survey and a boat transect. The shoreline method collects well-replicated samples from a (potentially) narrow marginal strip of the littoral zone, while the boat-based survey collects spatially un-replicated data between the water's edge and the depth of maximum colonisation (or the centre of the water body if colonisation extends across the lake).

In terms of assessing the macrophyte assemblage of the water body these two surveys yield different currencies of data. The shoreline survey data for each depth sampled is expressed as a percentage presence out of the 5 spot samples taken. These data can then be viewed as an intensively sampled shoreline end of the boat transect. However these data points cannot be regarded as equivalent to the spot samples collected along the boat transect because the shoreline area (between the waters edge and 0.75m depth) may have been over-sampled relative to the dispersion of the 10 points along the boat transect. If the density of sampling points in the two surveys is the same then the data points are given equal weighting. If on the other hand, the vegetated zone is highly compressed beyond the maximum depth considered by the shoreline survey, the shoreline data is weighted by a ratio of sites per metre on the boat transect to sites per metre on the shore transect.

Summary
The method uses 3 key aspects of the hydrophyte community to assess status. It has been designed to work along the full gradient of lake types found in the UK which range from low alkalinity, oligotrophic to very high alkalinity naturally eutrophic lakes. The assessment is based on the following characteristics of hydrophytes in response to nutrients:

Taxonomic indicators

4. Change in species composition of the community.
Metric (a) - Score of nutrient affinity for each taxa (Lake Macrophyte Nutrient Index or LMNI) derived statistically from 4500 surveys.
5. A unimodal response of the taxonomic or functional diversity of hydrophytes (number of taxa or number of functional groups)
Metric (b) - Number of functional groups. Species are assigned to one of 18 different functional groups. These groups are defined by physical form.
Metric (c) - Number of taxa present.

Abundance indicators

6. Change in the abundance of hydrophytes and macro algae
Metric (d) % cover of hydrophytes
Metric (e) % cover of macro algae

The method is designed to identify the anthropogenic effects of nutrient enrichment from a natural nutrient gradient, by comparing each of the above observed characteristics with reference values, expressed as an EQR. Rather than making arbitrary divisions of this gradient through a typology, lake specific reference values are determined from a series of environmental predictors. These are derived from a model developed from a population of reference lakes.

EQRs for each of these metrics are combined (after adjustment to a common scale), using weighted averaging according to the following principles:

- The primary indicator of status is provided by the EQR for the taxonomic composition. However aschanges in the taxonomic composition with nutrient enrichment are less pronounced in high alkalinity, naturally more fertile lakes, changes in diversity become progressively more important at this end of the alkalinity gradient.
- In all lake types a lower than expected diversity can decrease the final quality class, (by weighted averaging of the diversity and composition EQRs) if the diversity EQR indicates a worse class than the composition EQR.
- However, diversity is only allowed to increase the final classification (by a weighted averaging of the diversity and composition EQRs) if the diversity EQR indicates a better class than the composition EQR, in higher alkalinity lakes, by using a variable weighting factor which increases along a reference nutrient gradient.

- Where the % cover or the proportion of macro-algae indicate a worse class[5] than the taxonomic indicators (Cover or macro-algal EQRs are less than the overall taxonomic EQR) the final status is reduced by weighted averaging of the respective EQRs.

2.5. IE- Free Macrophyte Index

The following describes the adaptation of the calculation of the Free Macrophyte Index for the Intercalibration Process. It was developed to cover all types of Irish lakes and therefore is not type specific.

There are 6 components to the Macrophyte Index (Free et al., 2005):

1. Zc
2. Mean depth of presence
3. RF% Chara
4. RF% (percentage relative frequency) Elodeids
5. Plant trophic score
6. RF% Tolerant taxa

There are conditions for assigning values for some of the metrics (see relevant sections). Only the submerged and floating taxa listed in Table (Palmer et al. 1992) were utilised in devising the index and calculating metrics. This list is not exclusive, any submerged and floating taxa encountered should be included in the analysis (see Table).

The Index is dependent on expressing data as percentage relative frequency. Therefore, transect data is required. For the intercalibration process, method differences should be accounted for and data adjusted appropriately to eliminate bias. In particular, care should be taken where sampling methods concentrate on the shore.

Maximum transect depth

The maximum transect depth must be determined first before scores can be assigned to Zc – Maximum Depth of Colonisation and Mean depth of presence. As it suggests, the maximum transect depth is the maximum depth recorded regardless of whether macrophytes were present or not.

[5] High cover is never allowed to improve status

1. Zc – Maximum Depth of Colonisation

As it suggests, Maximum Depth of Colonisation is the maximum depth at which plants were recorded. A score is not assigned where Zc is less than 3 m and is between 80 (i.e >80%) and 100% of the maximum transect depth recorded. This is done to prevent a low score being assigned to shallow lakes.

See examples in Table C-2-5.

2. Mean depth of presence

A score is not assigned for the average depth of presence if it is less than 1.8 m and is within 50% of the maximum transect depth. This is done to prevent a low score being assigned to shallow lakes. See examples in **Error! Reference source not found.**.

3. RF% Chara

This is the sum of the RF% of all Chara spp. This metric is only included for lakes with an alkalinity of 100mg l^{-1} $CaCO_3$.

Calculating % Relative Frequency (RF%)

1. Use only taxa identified as submerged or floating according to Palmer et al. (1992) in the calculation, exclude all others (Table).
2. Sum occurrence of each taxa (do a count of each taxa column) e.g. Chara spp., occurred at 10 transect points
3. Sum occurrences of all taxa (sum counts of each taxa column) e.g. Chara =10, Sp A= 20, Sp B=5 therefore total =35 (occurrence of all taxa)
4. Relative Frequency for Chara spp. = (10/35)*100=29%

4. RF% Elodeids

This is the sum of the RF% of all elodeid like plants. Again, this metric will only add to a 100 if elodeids are the only plants present. Elodeids (functional form – resembles Elodea spp. as opposed to rosette or isoteid forms which resemble Isoetes sp.) were defined according to the list in Jensen (1979) which is not exclusive (**Error! Reference source not found.**). If a new taxa is encountered with an elodeid form (extends into the water column) then it is included in the calculation.

5. Plant trophic score

Plant trophic scores are presented in **Error! Reference source not found.**. The Plant trophic score was calculated based on the list of submerged and floating taxa listed in **Error! Reference source not found.** that were present in a lake i.e. on a lake basis not for records on a transect basis. The scores were summed and the average calculated. Note: that other moss and Filamentous algae were scored, these are not listed in Palmer et al. (1992) - see Macrophyte chapter in Free et al. (2005) for development of the Plant Trophic Score.

1. Assign relevant scores to taxa
2. average trophic scores

6. %RF Tolerant taxa

Tolerant taxa are also listed in **Error! Reference source not found.**. They are any taxa that had a TP score > 25 µg l^{-1} (see Macrophyte chapter in Free et al. (2005) for development). Percentage relative frequency (%RF) is the sum of their relative frequencies and only adds up to a 100% if they are the only taxa present. (Note: this highlights the importance of identification to species in the field). Sum the RF% for taxa with a plant trophic score greater than 25 µg l^{-1}. The full list of submerged and floating taxa for the AGIG is presented in **Error! Reference source not found.** with assigned trophic scores. Tolerant taxa and elodeids forms are also identified.

Macrophyte Index

Each of the above metrics were scaled from 0.1 to 1. Scores are assigned based on the metric value according **Error! Reference source not found.**. The average of the assigned metric scores is the Index value.

Table C-2-5a. The list of submerged and floating taxa from Palmer et al. (1992). Taxa not encountered during Irish Lake Surveys are highlighted in bold. Taxa used in the calculation of %RF for Irish surveys are also listed.

Palmer's taxa	Taxa used in calc of %RF for Irish Surveys
Apium inundatum	Apium inundatum
Callitriche hamulata	Callitriche hamulata
Callitriche hermaphrodita	Callitriche hermaphrodita
	Callitriche sp.
Callitriche obtusangula	
Callitriche stagnalis	
Ceratophyllum demersum	Ceratophyllum demersum
	Ceratophyllum submersum
Chara sp.	Chara sp.
Elatine hexandra	Elatine hexandra
Eleocharis acicularis	
Elodea canadensis	Elodea canadensis
Elodea nuttallii	
	Eriocaulon septangulare
	filamentous algae
Fontinalis antipyretica	Fontinalis antipyretica
Glyceria fluitans	
Hippuris vulgaris	Hippuris vulgaris
	Hydrocharis morsus-ranae
	Isoetes echinospora
Isoetes lacustris	Isoetes lacustris
Juncus bulbosus	Juncus bulbosus
	Lemna gibba
Lemna minor	Lemna minor
	Lemna polyrrhiza
Lemna trisulca	Lemna trisulca
Litorella uniflora	Litorella uniflora
Lobelia dortmanna	Lobelia dortmanna
Myriophyllum alterniflorum	Myriophyllum alterniflorum
Myriophyllum spicatum	Myriophyllum spicatum
	Myriophyllum verticillatum
	Najas flexilis
Nitella sp.	Nitella sp.
Nuphar lutea	Nuphar lutea
Nuphar pumila	
Nymphea alba	Nymphea alba
	Other Moss
Oenanthe aquatica	

Polygonum amphibium	Polygonum amphibium
Potamogeton alpinus	Potamogeton alpinus
Potamogeton berchtoldii	Potamogeton berchtoldii
Potamogeton crispus	Potamogeton crispus
Potamogeton filiformis	Potamogeton filiformis
Potamogeton friessi	Potamogeton friessi
Potamogeton gramineus	Potamogeton gramineus
Potamogeton lucens	Potamogeton lucens
Potamogeton natans	Potamogeton natans
Potamogeton obtusifolius	
Potamogeton pectinatus	Potamogeton obtusifolius
Potamogeton perfoliatus	Potamogeton pectinatus
Potamogeton polygonifolius	Potamogeton perfoliatus
	Potamogeton polygonifolius
Potamogeton praelongus	
Potamogeton pusillus	Potamogeton pusillus
	Potamogeton sp
	Potamogeton x nitens
	Potamogeton zizii
Potamogeton trichoides	
Ranunculus aquatilis	
Ranunculus baudotii	
Ranunculus circinatus	Ranunculus circinatus
Ranunculus hederaceus	
Ranunculus peltatus	
Ranunculus trichophylus	
Scirpus fluitans	
	Ranunculus penicillatus var penicillatus
	Sagittaria sp
Sparganium angustifolium	Sparganium angustifolium
Sparganium emersum	Sparganium emersum
Sparganium minimum	Sparganium minimum
Sphagnum sp	Sphagnum sp
Subularia aquatica	Subularia aquatica
	Unidentified submergent
Utricularia intermedia	Utricularia intermedia
	Utricularia sp.
Utricularia minor	
Utricularia vulgaris	Utricularia vulgaris
Zannichellia	Zannichellia

Table C-2-5b Examples of how to apply scoring restrictions to Zc. % is the Zc/max. transect depth*100.

Z_C	max. transect depth	%	Score??	Score
1.8	2	90.00	no score	
2.6	3.2	81.25	no score	
2.6	2.8	92.86	no score	
2.9	4	72.50	score	0.7
2.9	3.5	82.86	no score	
2.9	3	96.67	no score	
2.9	3.7	78.38	score	0.7
3	3	100.00	score	0.7
3	6	50.00	score	0.7
3	6	50.00	score	0.7
4	6	66.67	score	0.8
5	6	83.33	score	0.9

Table C-2-5c Examples of how to apply scoring restrictions to average depth of presence. %

average depth of presence	Max Transect Depth (m)	%	z presence score
0.6	1	60.00	No score
0.7	0.9	77.78	No score
0.9	1.8	50.00	0.3
1	1.7	58.82	No score
1.1	1.1	100.00	No score
1.1	1.9	57.89	No score
1.1	1.8	61.11	No score
1.1	2.1	52.38	No score
1.2	2	60.00	No score
1.3	2.2	59.09	No score
1.3	2.5	52.00	No score
1.5	1.6	93.75	No score
1.6	2.9	55.17	No score
1.7	2.8	60.71	No score
1.8	12.8	14.06	0.9
1.8	5.4	33.33	0.9
1.9	2.8	67.86	0.9
1.9	2.3	82.61	0.9
2	3.2	62.50	0.9

is the average depth of presence/max. transect depth*100.

Table C-2-5d List of elodeid forms after Jensen (1979) with taxa selected from Palmer et al. (1992) with an elodeid form. Bolded taxa were not found in the 2000-2003 Irish Lakes surveys. The list is not exclusive – any elodeid form taxa encountered should be included.

Taxa	Jensen	Palmer et al. (2001)
Apium inundatum	1	
Apium nodiflorum		1
Ceratophyllum demersum	1	
Ceratophyllum submersum		1
Elodea canadensis	1	
Juncus fluvitans	1	
Juncus sp.		1
Myriophyllum alterniflorum	1	
Myriophyllum spicatum	1	
Myriophyllum verticillatum		1
Nitella sp.	1	
Potamogeton crispus	1	
Potamogeton fresii	1	
Potamogeton gramineus		1
Potamogeton lucens		1
Potamogeton obtusifolius		1
Potamogeton pectinatus	1	
Potamogeton perfoliatus	1	
Potamogeton polygonifolius		1
Potamogeton sp		1
Potamogeton x nitens		1
Ranunculus circinatus	1	
Ranunculus penicillatus var penicillatus		1
Ranunculus sp.		1
Ranunculus sceleratus		1
Utricularia intermedia	1	
Utricularia sp.		1
Utricularia vulgaris	1	

Table C-2-5e Weighted spring TP (µg l^{-1}) where taxa present. The score was calculated using data from all lakes (n = 159). The highlighted taxa were not listed in Palmer et al. (1992). After Free et al. (2005).

Taxa	Weighted TP of lakes where taxa present (Scores)	n	Tolerant taxa
Ranunculus penicillatus var penicillatus	7	5	
Utricularia intermedia	7	5	
Lobelia dortmanna	10	47	
Eriocaulon septangulare	11	26	
Isoetes lacustris	12	55	
Juncus bulbosus	15	55	
Elatine hexandra	15	22	
Sphagnum sp	17	8	
Myriophyllum alterniflorum	17	46	
Hippuris vulgaris	20	12	
Nitella sp.	20	62	
Nymphea alba	21	19	
Utricularia vulgaris	21	25	
Sagittaria sp	22	13	
Chara sp.	23	70	
Other Moss	23	31	
Potamogeton gramineus	23	16	
Fontinalis antipyretica	26	78	T
Potamogeton perfoliatus	28	43	T
Potamogeton pectinatus	31	17	T
Lemna trisulca	31	35	T
Myriophyllum spicatum	32	27	T
Litorella uniflora	34	109	T
Potamogeton natans	34	51	T
Callitriche hamulata	34	6	T
Potamogeton lucens	35	32	T
Potamogeton berchtoldii	37	34	T
Filamentous algae	39	96	T
Sparganium emersum	40	46	T
Nuphar lutea	43	66	T
Elodea canadensis	48	62	T
Potamogeton obtusifolius	54	14	T
Potamogeton crispus	59	10	T
Ceratophyllum demersum	62	9	T
Polygonum amphibium	67	12	T
Callitriche sp.	68	13	T
Lemna minor	88	11	T
Lemna polyrrhiza	145	5	T

Table C-2-5f List of taxa from AGIG IC data with assigned trophic scores. Tolerant taxa and elodeids forms are identified.

Taxa list for AGIG	Trophic score	Tolerant taxa	ELODEIDS
Apium inundatum			ELODEIDS
Callitriche hamulata	34	T	ELODEIDS
Callitriche hermaphrodita	68	T	ELODEIDS

Callitriche sp.	68	T	ELODEIDS
Ceratophyllum demersum	62	T	ELODEIDS
Ceratophyllum submersum			ELODEIDS
Chara spp.	23		
Elatine hexandra	15		
Elatine hydropiper			
Elodea canadensis	48	T	ELODEIDS
Elodea nuttallii	48	T	ELODEIDS
Enteromorpha			
Eriocaulon septangulare	11		
Filamentous algae	39	T	ELODEIDS
Fontinalis antipyretica	26	T	ELODEIDS
Hippuris vulgaris	20		ELODEIDS
Hydrocharis morsus-ranae			
Isoetes echinospora			
Isoetes lacustris	12		
Juncus bulbosus	15		
Lemna gibba			
Lemna minor	88	T	
Lemna polyrrhiza	145	T	
Lemna trisulca	31	T	
Litorella uniflora	34	T	
Lobelia dortmanna	10		
Luronium natans			
Myriophyllum alterniflorum	17		ELODEIDS
Myriophyllum spicatum	32	T	ELODEIDS
Myriophyllum verticillatum			ELODEIDS
Najas flexilis			ELODEIDS
Nitella sp.	20		ELODEIDS
Nuphar lutea	43	T	
Nuphar x spenneriana			
Nymphaea sp.	21		
Nymphea alba	21		
Nymphoides peltata			
Other Moss	23		ELODEIDS
Polygonum amphibium	67	T	
Potamogeton alpinus			ELODEIDS
Potamogeton berchtoldii	37	T	ELODEIDS
Potamogeton crispus	59	T	ELODEIDS
Potamogeton filiformis			ELODEIDS
Potamogeton friessi			ELODEIDS
Potamogeton gramineus	23		ELODEIDS
Potamogeton lucens	35	T	ELODEIDS
Potamogeton natans	34	T	NYMPHAEIDS
Potamogeton nodosus			ELODEIDS
Potamogeton obtusifolius	54	T	ELODEIDS
Potamogeton pectinatus	31	T	ELODEIDS
Potamogeton perfoliatus	28	T	ELODEIDS
Potamogeton polygonifolius			ELODEIDS
Potamogeton praelongus			ELODEIDS
Potamogeton pusillus			ELODEIDS
Potamogeton spp			ELODEIDS
Potamogeton x nitens			ELODEIDS
Potamogeton zizii			ELODEIDS
Ranunculus circinatus			ELODEIDS
Ranunculus penicillatus var penicillatus	7		ELODEIDS
Ranunculus sp.			ELODEIDS

Sagittaria sp	22		ELODEIDS
Sparganium angustifolium			ELODEIDS
Sparganium emersum	40	T	ELODEIDS
Sparganium minimum			ELODEIDS
Sparganium natans			ELODEIDS
Sphagnum sp			
Sparganium spp.			ELODEIDS
Subularia aquatica			
Unidentified submergent			
Utricularia intermedia	7		ELODEIDS
Utricularia spp.			ELODEIDS
Utricularia vulgaris	21		ELODEIDS
Zannichellia			ELODEIDS

Table C-2-5g. Table of scaled deciles for five metrics that had a log-linear response to spring TP. After Free et al. (2005).

Scaled deciles	Plant trophic score	Zc	Mean depth of presence	RF% Elodeids (functional group)	RF% Chara	RF% Tolerant
1.0	<28.2	>5.1	>2.00	<19	>67	<26
0.9	28.2 - 30.4	5.1 - 4.1	2.00 - 1.66	19 - 31	67 - 61	26.0 - 37.9
0.8	30.4 - 31.8	4.1 - 3.5	1.66 - 1.49	31 - 37	61 - 45	37.9 - 51.7
0.7	31.8 - 33.1	3.5 - 2.9	1.49 - 1.35	37 - 48	45 - 29	51.7 - 60.4
0.6	33.1 - 34.0	2.9 - 2.5	1.35 - 1.25	48 - 53	29 - 23	60.4 - 70.1
0.5	34.0 - 35.2	2.5 - 2.1	1.25 - 1.13	53 - 59	23 - 10	70.1 - 77.9
0.4	35.2 - 38.2	2.1 - 1.8	1.13 - 0.94	59 - 65	10 - 7	77.9 - 84.8
0.3	38.2 - 40.2	1.8 - 1.6	0.94 - 0.81	65 - 75	7 - 5	84.8 - 90.0
0.2	40.2 - 43.7	1.6 - 1.0	0.81 - 0.30	75 - 80	5 - 2	90.0 - 98.9
0.1	>43.7	<1.0	<0.30	>80	<2	>98.9

Part 3 - Reference criteria

Criteria	Finland	Sweden	Norway	UK	Ireland
Pressure criteria					
Agriculture 1)	In data sets at present mainly ≤ 10 %	<10% of catchment	<5%	< 10% arable or intensive grazing	
Point sources	No major point sources	No major point sources	No major point sources		No major point sources
Urbanised area		<0.1% of catchment			No urbanisation i.e. villages/ towns <1%
Population density			< 5 p.e./km2	<10 p.e./km2	
Other pressures	No significant water level regulation or morphological changes	Annual mean ≥pH 6, For pH < 6 a correction factor for natural acidity has been used		No fish farms	No intensive use of lake i.e. abstractions

Impact criteria					
Total P		<10 ug/L, or higher if high colour	<11 ug/L, or higher if high colour		<10 ug/L
Chlorophyll			< 4 ug/L (low alk. clear types) (<6 for other types)		< 4 ug/L
Biovolume phytoplankton					
Paleodata				No significant change in diatom community compared to bottom of sediment core (if available	Selection of some sites subsequently evaluated from paleodata on diatoms
Expert judgement	Yes, partly, based on available information of the site	no	yes	Yes	yes

1) Agriculture: This is mainly judged from visual observation of GIS land use data.

Annex C – Part 4 - List of Reference Sites used for NGIG Macrophyte Intercalibration

Table C-4 List of Reference Sites used for NGIG Macrophyte Intercalibration

LAKE NAME	Country	Unique ID	IC type
Aartojärvi	FI	F153	102
Äkäsjärvi	FI	F28	101
Alajärvi	FI	F1	101
Alajärvi	FI	F39	102
Ala-Kintaus	FI	F40	102
Ala-Kivijärvi	FI	F197	202
Ala-Nampajärvi	FI	F198	202
Alempi Akujärvi	FI	F41	102
Arajärvi	FI	F154	102
Herajärvi	FI	F2	101
Hirvasjärvi	FI	F155	102
Hirvasjärvi	FI	F45	102
Iijärvi	FI	F3	101
Inarijärvi l. Anarjävri	FI	F4	101
Iso Kallijärvi	FI	F46	102
Iso Kausjärvi	FI	F47	102
Iso Lohijärvi	FI	F48	102
Iso Savijärvi	FI	F201	202
Iso-Hyypiö	FI	F177	201
Jääsjärvi	FI	F5	101
Kalapää träsk	FI	F50	102
Kalliojärvi	FI	F52	102

Kallunkijärvi	FI	F203	202
Kampsajärvi	FI	F204	202
Kanajärvi	FI	F53	102
Karhujärvi	FI	F29	101
Kärväsjärvi	FI	F54	102
Katisko-Saarijärvi	FI	F55	102
Kätkäjärvi	FI	F30	101
Kattajärvi	FI	F56	102
Kaukuanjärvi	FI	F159	102
Keihäsjärvi	FI	F57	102
Kelontekemäjärvi	FI	F206	202
Kelujärvi	FI	F207	202
Kevojärvi	FI	F60	102
Kilpisjärvi	FI	F31	101
Kiurujärvi	FI	F210	202
Kivesjärvi	FI	F61	102
Kolmosjärvi	FI	F6	101
Kotkajärvi	FI	F212	202
Kukasjärvi	FI	F161	102
Kukasjärvi	FI	F64	102
Kukasjärvi	FI	F65	102
Kuohattijärvi	FI	F67	102
Kuoksajärvi	FI	F68	102
Kuolajärvi	FI	F215	202
Kuorinka	FI	F8	101
Kuusijärvi	FI	F216	202
Kuutusjärvi	FI	F9	101
Kyröjärvi	FI	F71	102
Kyynelmyksenjärvi	FI	F72	102
Lankojärvi	FI	F73	102
Lautajärvi	FI	F75	102
Lestijärvi	FI	F76	102
Leusjärvi	FI	F217	202
Lika-Pyöree	FI	F77	102
Listimäjärvi	FI	F78	102
Livojärvi, Säikkä	FI	F32	101
Luirojärvi	FI	F33	101
Lunkinjärvi	FI	F10	101
Majamalompolo	FI	F82	102
Mäntyjärvi	FI	F162	102
Marrasjärvi	FI	F83	102
Miekojärvi	FI	F84	102
Misijärvi	FI	F219	202
Mourujärvi	FI	F163	102
Mujejärvi	FI	F85	102
Muotkajärvi	FI	F220	202
Mutusjärvi	FI	F11	101
Naruskajärvi-Kullajärvi	FI	F165	102
Neitijärvi	FI	F88	102
Nitsijärvi	FI	F12	101
Oivanginjärvi	FI	F224	202
Onkamojärvi	FI	F225	202

Orajärvi	FI	F226	202
Orivesi	FI	F93	102
Ounasjärvi	FI	F166	102
Päijänne	FI	F228	202
Pallasjärvi	FI	F34	101
Palojärvi	FI	F96	102
Pasmajärvi	FI	F99	102
Perunkajärvi	FI	F229	202
Pieni Kuukasjärvi	FI	F103	102
Pieni-Uurainen	FI	F14	101
Posionjärvi	FI	F168	102
Puruvesi	FI	F15	101
Puula	FI	F16	101
Pyhäjärvi	FI	F184	201
Pyhäjärvi	FI	F231	202
Pyhäjärvi	FI	F232	202
Pyhäselkä	FI	F111	102
Rastinjärvi - Kuivajärvi	FI	F234	202
Rattosjärvi	FI	F115	102
Rehja-Nuasjärvi	FI	F116	102
Ristijärvi	FI	F117	102
Ruohonvetämäjärvi	FI	F18	101
Ruostejärvi	FI	F119	102
Ruuhijärvi	FI	F36	101
Sääksjärvi	FI	F19	101
Sääskijärvi	FI	F121	102
Salkolanjärvi	FI	F122	102
Särki-Kämä	FI	F124	102
Sarmijärvi	FI	F20	101
Seipäjärvi	FI	F169	102
Seitajärvi	FI	F170	102
Simojärvi, Vierelä	FI	F127	102
Sotkajärvi	FI	F240	202
Suomunjärvi	FI	F131	102
Suuri-Vahvanen	FI	F21	101
Suvasvesi	FI	F132	102
Sylkky	FI	F189	201
Syväjärvi	FI	F171	102
Tervajärvi	FI	F137	102
Tiilikka	FI	F138	102
Törmäsjärvi	FI	F22	101
Tuormusjärvi	FI	F140	102
Tuuranjärvi	FI	F243	202
Unari	FI	F141	102
Urajärvi	FI	F191	201
Utkujärvi	FI	F172	102
Uurainen	FI	F23	101
Vaalajärvi	FI	F173	102
Vahvajärvi	FI	F24	101
Vainolanjärvi	FI	F144	102
Valkkojärvi	FI	F146	102
Vastusjärvi	FI	F25	101

Venejärvi	FI	F26	101
Viinijärvi	FI	F249	202
Virojärvi	FI	F147	102
Vuojärvi	FI	F250	202
Vuoksijärvi	FI	F175	102
Vuontisjärvi	FI	F27	101
Ylempi Akujärvi	FI	F150	102
Ylijärvi	FI	F151	102
Yli-Kitka	FI	F194	201
Ylimmäinen Sankajärvi	FI	F152	102
Ylinen Sieppijärvi	FI	F252	202
Anaserd	IE	IE2	201
Bane	IE	IE73	301
Bane	IE	IE74	301
Barfinnihy	IE	IE9	101
Barra	IE	IE10	102
Beltra	IE	IE12	202
Bunny	IE	IE75	301
Bunny	IE	IE76	301
Caragh	IE	IE14	101
Cloongat	IE	IE17	102
Craghy	IE	IE18	102
Doo (MO)	IE	IE22	101
Easky	IE	IE25	102
Fad (west)	IE	IE27	102
Gartan	IE	IE30	202
Glencar	IE	IE87	301
Golagh	IE	IE33	102
Guitane	IE	IE35	101
Guitane	IE	IE36	101
Hibbert	IE	IE38	101
Kiltooris	IE	IE40	202
Kindrum	IE	IE93	301
Maumwee	IE	IE45	201
Nafooey	IE	IE52	101
Nahasleam	IE	IE54	102
Owel	IE	IE98	301
Owel	IE	IE99	301
Shindilla	IE	IE61	102
Talt	IE	IE105	301
Templehouse	IE	IE137	302
Upper	IE	IE66	102
Waskel	IE	IE67	102
Alsvågvatn	NO	NO21	101
Ånneslandsvatn	NO	NO7	102
Åsvolltjønn	NO	NO45	101
Atnasjøen	NO	NO46	101
Barstadvatn	NO	NO48	101
Bergskogvatn	NO	NO150	201
Bergsvatn	NO	NO49	101
Bergsvatn	NO	NO50	101
Bjørnevatn/Skrukkebukta	NO	NO22	101

Bjorvatn S for Mollestad	NO	NO44	101
Blåvatn	NO	NO8	102
Breisjøen	NO	NO51	101
Brøbørvatn	NO	NO9	102
Brossvikvatn	NO	NO35	101
dam Høvikvollen	NO	NO100	202
dam Nærsnes	NO	NO103	202
dam Nordstrand	NO	NO104	202
Damsgardvatn	NO	NO152	201
Dingjevatn	NO	NO52	101
Djupvatn	NO	NO131	201
Dybingen	NO	NO36	101
Eiavatn	NO	NO37	101
Eidshaugvatn	NO	NO11	102
Einavatn	NO	NO153	201
Evangervatn	NO	NO54	101
Farris	NO	NO39	101
Finnslandsvatn	NO	NO56	101
Fiskumvatn	NO	NO132	201
Fjellgardsvatn (Vikedalsvassd)	NO	NO57	101
Fjellvatn	NO	NO58	101
Fotlandsvatn	NO	NO59	101
Gaupmyrdammen	NO	NO106	202
Gautlandsvatn	NO	NO60	101
Gjerstadvatn	NO	NO1	102
Gjuvvatn	NO	NO61	101
Grunntjørn	NO	NO12	102
Grunnvatn	NO	NO134	201
Hafslovatn	NO	NO40	101
Hartvigsvatn	NO	NO135	201
Heimre Fagervatn	NO	NO63	101
Heldalsvatn	NO	NO64	101
Henstjern	NO	NO110	202
Herefossfjorden	NO	NO65	101
Herefossfjorden	NO	NO66	101
Hersjøen	NO	NO199	301
Hilleslandsvatn	NO	NO136	201
Jostakktjørn	NO	NO112	202
Jøtulhaugvatn	NO	NO161	201
Kjerkhaugvatn	NO	NO162	201
Kjervallvatn	NO	NO69	101
Klavavatn	NO	NO13	102
Knutvatn	NO	NO163	201
Kvernengvatn	NO	NO113	202
Langevatn (Gulen)	NO	NO23	101
Langvatn (FI)	NO	NO24	101
Langvatn (NO)	NO	NO138	201
Lappuluobbal	NO	NO15	102
Laugen	NO	NO114	202
Lavikvatn	NO	NO71	101
Leksarvatn	NO	NO25	101
Litlevatn	NO	NO207	301

Litlvatn (Kvingla)	NO	NO116	202
Lombola	NO	NO139	201
Lømsen	NO	NO140	201
Lønavatn	NO	NO26	101
lulit Cædnujavrit	NO	NO6	102
Lundevatn NØ	NO	NO16	102
Lutvatn	NO	NO164	201
Lyngsnesvatn	NO	NO184	302
Lynvatn	NO	NO141	201
Mårvatn	NO	NO17	102
Mindedammen	NO	NO165	201
Møkkelandsvatn	NO	NO142	201
Nåsvatn	NO	NO143	201
Nattmålvatn	NO	NO210	301
Nautåvatn	NO	NO118	202
Nedre Lundetjern	NO	NO72	101
Nervatn	NO	NO144	201
Nesevatn	NO	NO73	101
Nesheimvatn	NO	NO74	101
Nesvatn	NO	NO92	202
Nøklevatn	NO	NO145	201
Nordbytjern	NO	NO211	301
Nordvatn	NO	NO119	202
Oggevatn	NO	NO27	101
Osavatn	NO	NO75	101
Osplivatn	NO	NO18	102
Øvre Fagervatn	NO	NO76	101
Øvre Lundetjern	NO	NO19	102
Padderudvatn	NO	NO185	302
Randsfjorden	NO	NO169	201
Refstadvatn Ø	NO	NO77	101
Resvann (Risvann)	NO	NO28	101
Røyravatn (Vikedalsvassd)	NO	NO78	101
Sammalnjavejavrit	NO	NO79	101
Sandvatn	NO	NO80	101
Selura	NO	NO41	101
Selura	NO	NO42	101
Skråtjern	NO	NO171	201
Sommarvatn	NO	NO121	202
Steinsfjorden	NO	NO147	201
Steinsvatn	NO	NO29	101
Stemmen	NO	NO30	101
Store Finntjenn	NO	NO82	101
Store Gryta	NO	NO83	101
Storvatn	NO	NO3	102
Storvatn (Dønna)	NO	NO191	302
Storveavatn	NO	NO93	202
Strandlivatn	NO	NO84	101
Svantjørn	NO	NO192	302
Svardalsvatn	NO	NO4	102
Svardalsvatn	NO	NO5	102
Svarthamarvatn	NO	NO123	202

Tamokvatn	NO	NO218	301
Tennvatn	NO	NO219	301
Torevatn	NO	NO85	101
Torevatn	NO	NO86	101
Torkelvatn	NO	NO126	202
Troldevatn	NO	NO87	101
Ulvenvatn	NO	NO221	301
Vallvatn	NO	NO148	201
Vardevatn	NO	NO88	101
Vardevatn	NO	NO89	101
Vatnet	NO	NO90	101
Vestervatn	NO	NO128	202
Vikevatn	NO	NO224	301
Yndedalsvatn	NO	NO33	101
Apmeljaure	S	S4	201
Armasjärvi	S	S5	102
BERGTRÄSKET	S	S6	102
Bjännsjön	S	S8	102
Björken	S	S9	201
Bysjön 1	S	S13	201
Dammsjön	S	S16	201
Dormen	S	S17	202
Fiolen	S	S22	101
Kitkiöjärvi	S	S34	102
Lången	S	S46	201
Långsjön	S	S47	101
Lisselacksen (Lill-)	S	S118	301
Mensträsket	S	S49	202
Merasjärvi	S	S50	101
Mettäjärvi	S	S52	102
Rammsjön	S	S68	101
Randijaure	S	S69	101
Rutajärvi	S	S71	102
Skäravattnet	S	S81	102
SÖDRA BERGSJÖN	S	S94	102
Stora Envättern	S	S85	101
Storacksen	S	S119	301
Syväjärvi	S	S92	102
Tallviksavan	S	S95	102
Tjeknalis	S	S96	101
Tuvtjärn	S	S100	202
Vajkijaure	S	S102	101
VALKEAJÄRVI	S	S103	101
VivunKijärvi	S	S110	102
Buttermere	UK	UK228	101
Cam Loch	UK	UK9	101
Craig Goch Reservoir	UK	UK217	101
Gloyw Lyn	UK	UK220	101
Hulma Water	UK	UK30	102
Kirk Loch	UK	UK250	302
Llyn Alwen	UK	UK6	101
Llyn Eiddwen	UK	UK223	101

Llyn Erddyn or 'Llyn Irddyn'	UK	UK215	101
Llyn Fach	UK	UK204	102
Llyn Gynon	UK	UK201	101
Llyn Hîr	UK	UK224	101
Llyn Idwal	UK	UK225	101
Llyn Llagi	UK	UK7	101
Llyn Ogwen	UK	UK226	101
Llynnoedd Ieuan	UK	UK202	101
Loch a' Ghriama	UK	UK32	101
Loch an Eion	UK	UK211	101
Loch Ascaig	UK	UK36	102
Loch Assynt	UK	UK8	201
Loch Bà	UK	UK48	101
Loch Ballygrant	UK	UK260	301
Loch Beannacharain	UK	UK43	101
Loch Calder	UK	UK259	301
Loch Clair	UK	UK210	101
Loch Craggie	UK	UK35	101
Loch Culaidh	UK	UK37	102
Loch Doilet	UK	UK213	101
Loch Dubh Camas an Lochain	UK	UK209	101
Loch Dughaill	UK	UK15	101
Loch Duntelchaig or 'Loch nan Geadas'	UK	UK14	201
Loch Eck	UK	UK10	101
Loch Eilt	UK	UK45	101
Loch Einich	UK	UK56	101
Loch Garve	UK	UK1	101
Loch Laidon	UK	UK238	101
Loch Laxavat Ard	UK	UK19	102
Loch Lossit	UK	UK261	301
Loch Maree	UK	UK16	101
Loch Maree	UK	UK237	101
Loch Mór	UK	UK18	201
Loch More	UK	UK33	101
Loch Muick	UK	UK41	101
Loch Naver	UK	UK34	101
Loch of Flatpunds	UK	UK28	202
Loch of Girlsta	UK	UK31	102
Loch of Swannay	UK	UK249	301
Loch of Tingwall	UK	UK256	301
Loch of Vatsetter	UK	UK27	202
Loch of Voe	UK	UK25	202
Loch of Watlee	UK	UK251	301
Loch Rannoch	UK	UK62	101
Loch Scadabhagh or 'Loch Scadavay'	UK	UK20	101
Loch Shiel	UK	UK46	101
Loch Tarff	UK	UK11	101
Lochan Bad an Losguinn	UK	UK212	101
Lochan Bealach Cornaidh	UK	UK206	101
Lochan Dubh Cadhafuaraich	UK	UK208	102
Lochan Feòir	UK	UK207	101
Lochan Fhionnlaidh	UK	UK205	101

Lochan Lairig Cheile	UK	UK214	101
Lough Naroon	UK	UK77	102
Sand Water	UK	UK257	301
Ullins Water	UK	UK26	101
unnamed	UK	UK254	301
Wast Water	UK	UK242	101
West Loch Ollay_2'	UK	UK263	301
Binnian Lough	UK_N	UK198	101
Blue Lough	UK_N	UK196	101
Craigfad A	UK_N	UK79	101
Eskinatowey Lough	UK_N	UK185	101
Fardrum Lough	UK_N	UK269	301
Innaghachola Lough	UK_N	UK199	101
Lough A Waddy	UK_N	UK98	201
Lough Atona	UK_N	UK110	101
Lough Doo	UK_N	UK127	201
Lough Hamul	UK_N	UK103	201
Lough Lee	UK_N	UK85	101
Lough Mulderg	UK_N	UK106	102
Lough Na Cranagh	UK_N	UK76	201
Lough Nabrickboy (B)	UK_N	UK125	201
Lough Nagor	UK_N	UK109	102
Lough Namanfin	UK_N	UK105	101
Lough Natroy	UK_N	UK115	102
Lough Navarad	UK_N	UK117	102
Lough Ouske	UK_N	UK186	102
Lough Scolban	UK_N	UK308	301
Loughanillan	UK_N	UK190	201
Loughascraban	UK_N	UK80	201
Loughnacally	UK_N	UK82	201
Loughnacree	UK_N	UK192	101
Loughnafreaghoge	UK_N	UK189	101
Lough-Na-Heery	UK_N	UK116	202
Meenaghmore Lough	UK_N	UK96	201
Meenatully lough	UK_N	UK95	101
The Fly Lough	UK_N	UK187	102
Tullynasiddagh Lough	UK_N	UK126	101
Unnamed (Kilbroney)	UK_N	UK197	102

Annex C – Part 5 - Development of a site-specific predictive model for reference ICCM

Participating MS contributed data on a total of 1074 surveys across all lake types of which 427 were nominated as reference sites. A model to predict site specific reference ICCM values was constructed from the global reference dataset using multiple linear regression with the most widely available background environmental variables (lake area, altitude, alkalinity and colour (as clear or humic only)) as predictors. This model confirmed the significance of colour as a model term. Since colour values on a continuous scale were not available for all countries separate models were developed thereafter for clear and humic lakes (Figure **C-5-1**). The global model was also used to identify outlying reference sites (i.e. those poorly predicted by the model) which were then screened against pressure data and deselected where appropriate.

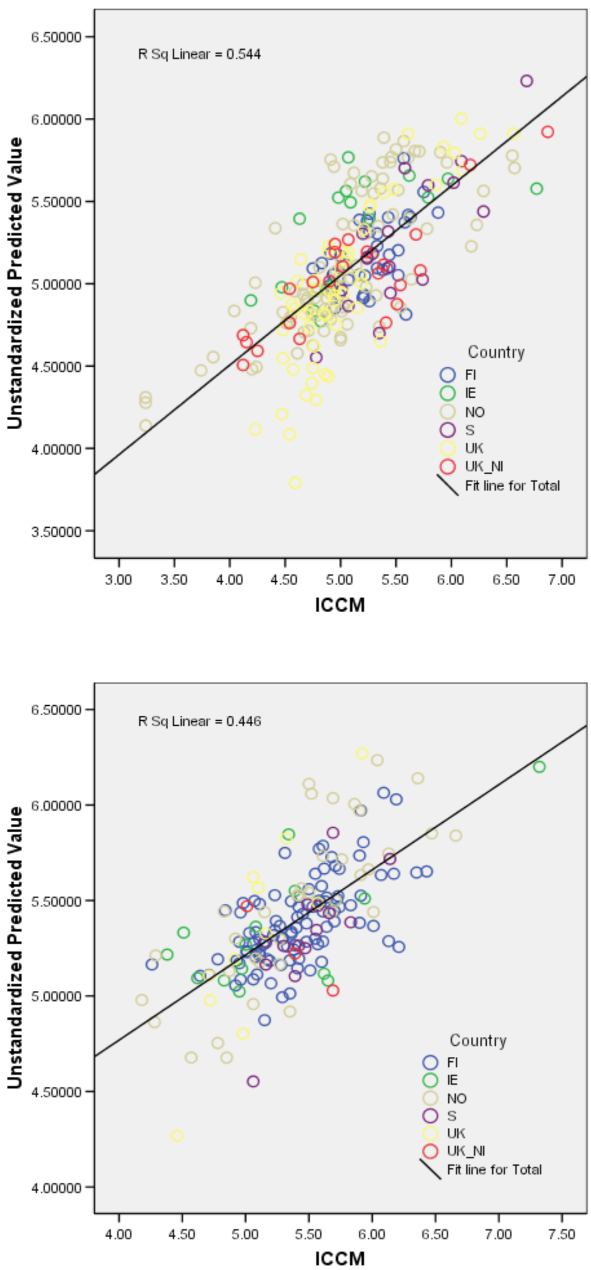


Figure C-5-1. Final models for clear (upper panel) and humic (lower panel) NGIG reference lakes using alkalinity, altitude and number of scoring taxa as predictors.

When selecting model terms model performance was enhanced significantly by the inclusion of the number of scoring taxa. This reflects (i) the intrinsic dependency of metrics based on a constrained set of ranks on the number of species present (as species number increases in reference sites a progressively higher set of ranking scores must be sampled) and (ii) a W-E biogeographical gradient of increasing richness for reference lakes relative to the prediction from a global model (Fig C-5-2 and Fig C-5-3).

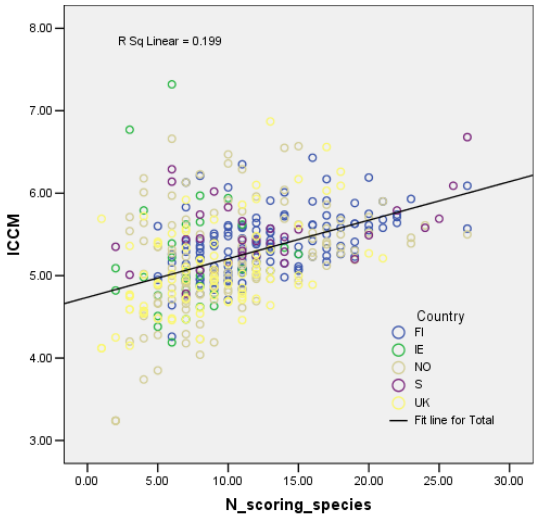


Figure C-5-2. Relationship between number of scoring taxa and ICCM values for reference sites

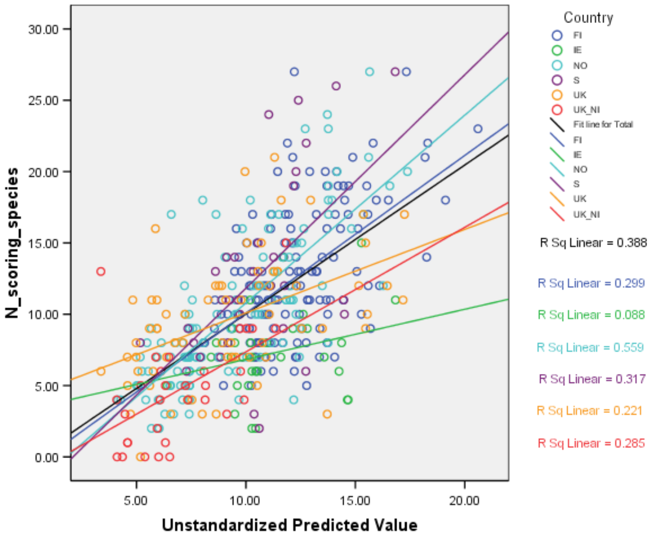


Figure C-5-3. Relationship between Observed and predicted number of scoring taxa (modelled using lake area, altitude, and alkalinity or their derivatives) on a country-by-country basis, illustrating higher richness for a given combination of area, altitude and alkalinity in the eastern NGIG countries.

Thus the most parsimonious models for prediction of expected ICCM in reference lakes were as follows.

Table C-5-1. Summary of multiple linear regression models for reference ICCM

Lake Colour	Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
Clear	1	.666(a)	.443	.441	.42545
	2	.732(b)	.536	.532	.38933
	3	.737(c)	.544	.538	.38677
Humic	1	.601(a)	.361	.358	.37959
	2	.654(b)	.428	.422	.36018
	3	.668(c)	.446	.436	.35558

a Predictors: (Constant), log_alk
b Predictors: (Constant), log_alk, N_scoring_species
c Predictors: (Constant), log_alk, N_scoring_species, Alt^2

Table C-5-2. Summary of final model terms for reference ICCM.

Colour	Term	Unstandardized Coefficients		Sig.
		B	Std. Error	
Clear	(Constant)	3.778829835	0.099172339	0.0000
	logalk	0.487148373	0.042078341	0.0000
	N_scoring_species	0.031416676	0.004995043	0.0000
	Alt^2	-6.02409E-07	2.9511E-07	0.0423
Humic	(Constant)	3.774294278	0.162497805	0.0000
	logalk	0.627738974	0.065836508	0.0000
	N_scoring_species	0.025180902	0.005512484	0.0000
	Alt^2	-2.14823E-06	9.09273E-07	0.0192

Where alkalinity is expressed as μeq/L, altitude in m and the number of scoring species is the number of species in the survey of that lake that qualify for inclusion in the ICCM (i.e. are consistently recorded by all participating countries).

Annex C – Part 6 – Reference conditions for the common metric (ICCM)

The range of reference values for the common metric (ICCM) is shown for each lake type and member state in fig C-6-1. The values show a progressive increase along a natural fertility gradient expressed by alkalinity and humic content and it should be noted that the reference ICCM is higher in Finland and Sweden for the majority of lake types. This is not an indication of differences in the criteria for selecting reference sites in these countries but a reflection of differences in reference conditions accounted for by the lake specific model approach.

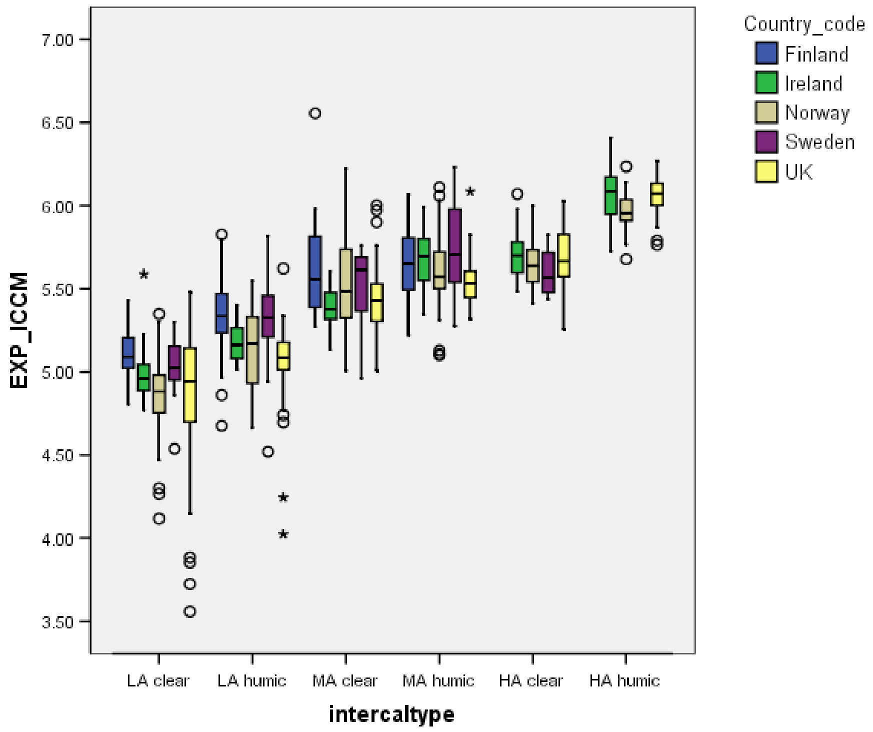


Fig. C-6-1 Range of modelled reference ICCM values for lakes in NGIG common data set.

The primary reason for the increased reference values is a W-E biogeographic gradient of increasing taxonomic richness for reference lakes (fig C-6-2).

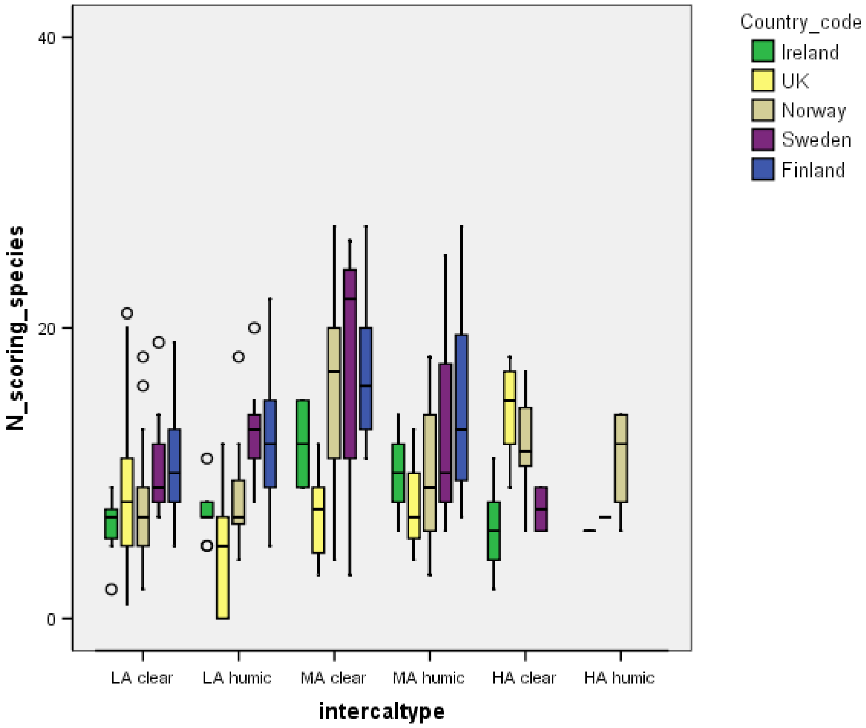


Fig C - 6 - 2. Range of the number of scoring species for reference lakes in NGIG common data set.

These bio-geographic differences account for what otherwise might be considered a difference in status of reference sites in some countries based on the observed ICCM values in reference sites (fig C-6-3).

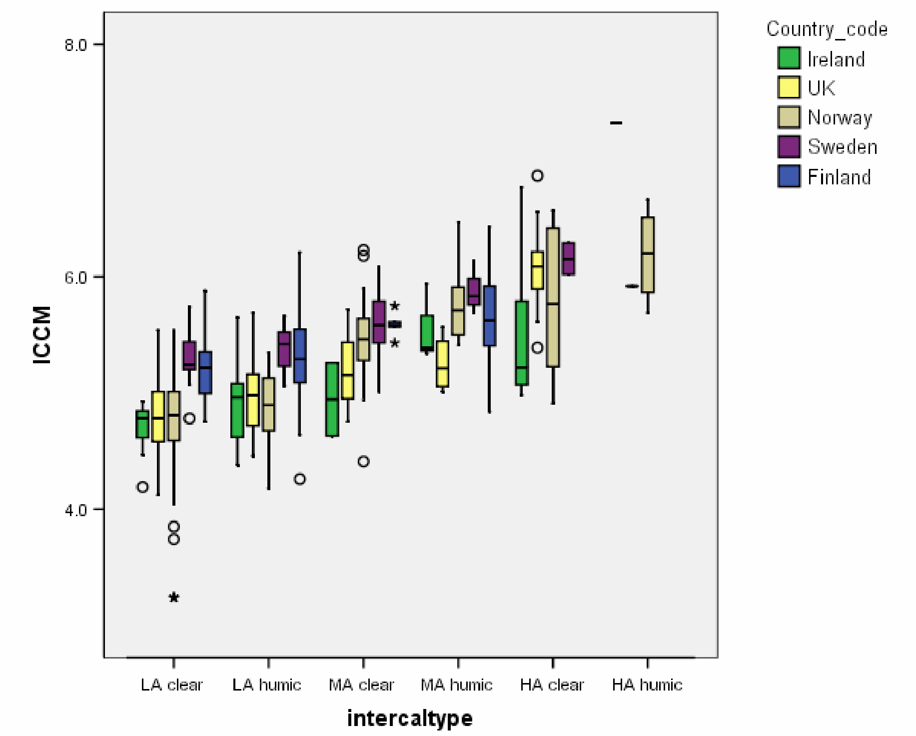


Fig C-6-3. Range of observed ICCM values in Northern GIG reference lakes

If the reference model is adequate for predicting reference values the range of ICCM EQRs (fig C-6-4) should be similar for each country if their selection of reference sites represents similar true status. Sweden and Finland generally have lower EQRs in their reference sites than other countries. This might reflect a different view of reference conditions (less pristine) but it may also reflect the inability of the reference model to account for bio-geographic effects.

A comparison of other impact indicators, phytoplankton biomass (chlorophyll a) and water transparency (secchi depth) in reference sites do not reveal any clear differences between Finland and Sweden in comparison to other countries in the NGIG (Fig C-6-5 & C-6-6) and **we conclude that the GIG selection of reference sites is broadly consistent within the GIG**

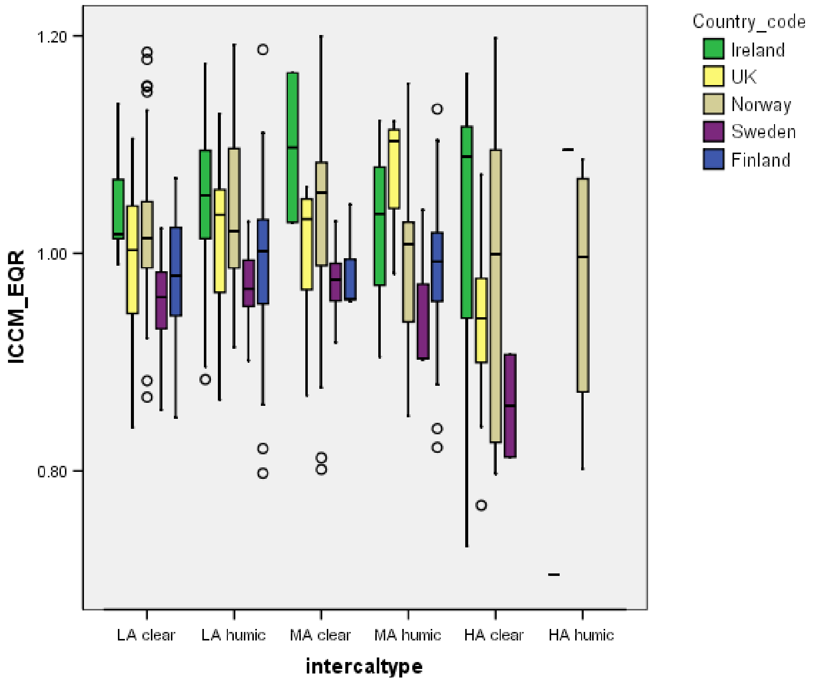


Fig C-6-4. Range of intercalibration common metric EQRs in NGIG Reference sites split by lake type and country

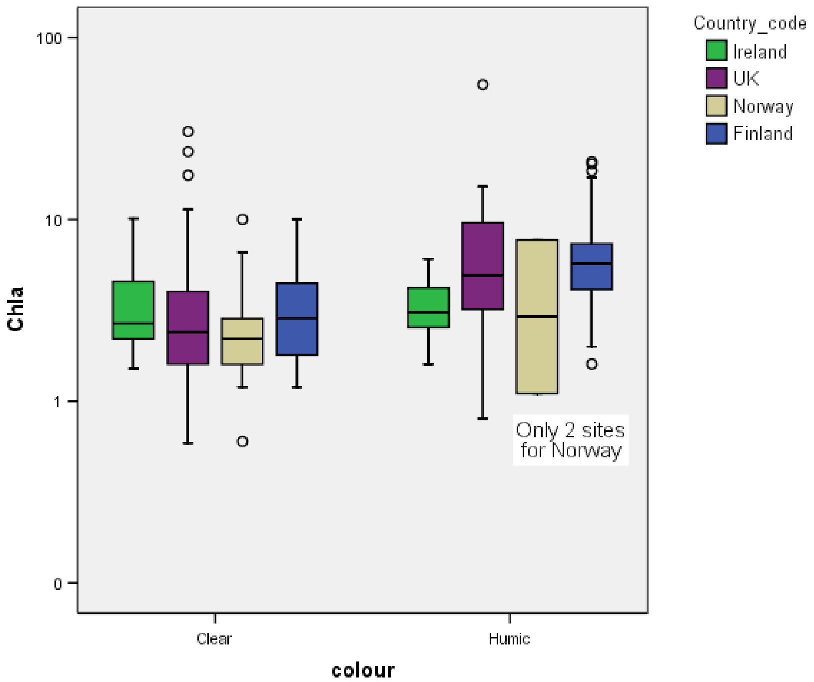


Fig C-6-5. Range of chlorophyll a values in GIG reference lakes, split by colour type and country.

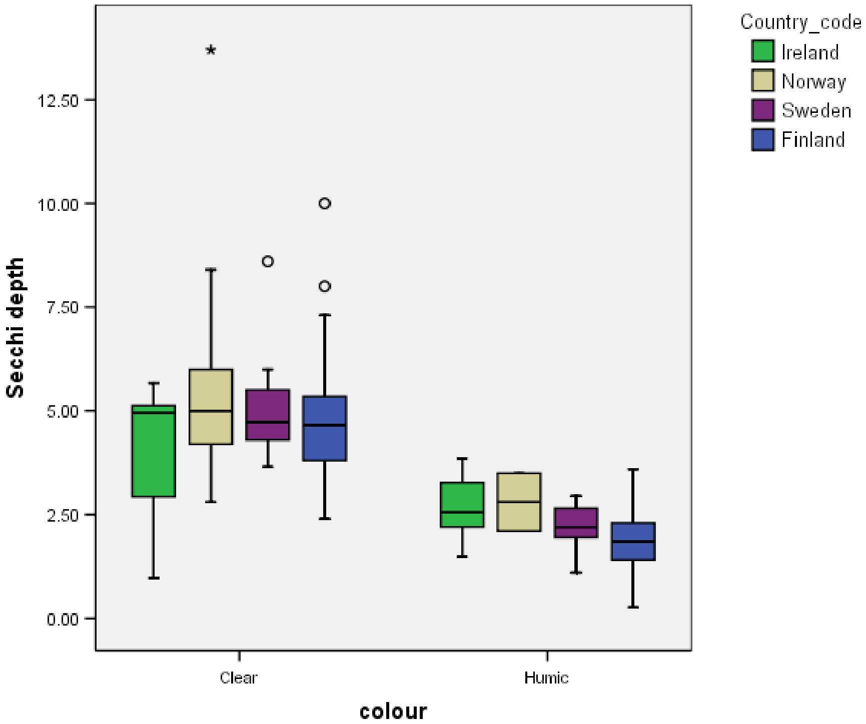


Fig C-6-6 Range of water transparency (mean secchi depth m) for reference lakes in NGIG divided by colour type and country.

Annex C – Part 7 - Relationship between impact indicators (total phosphorus, chlorophyll a and Secchi depth) and macrophyte status

The average ICCM boundary values calculated below can be used to divide the GIG data set into High, Good and Moderate or worse classes. There is a clear relationship between impact indicators (total phosphorus, chlorophyll a and secchi depth) and macrophyte status class as determined by both the ICCM metric and member state classifications for all lake types and countries, although the range of values is different for each country (Figs C- 7 - 4). This demonstrates that the NGIG macrophyte classifications represent changes linked to the eutrophication pressure

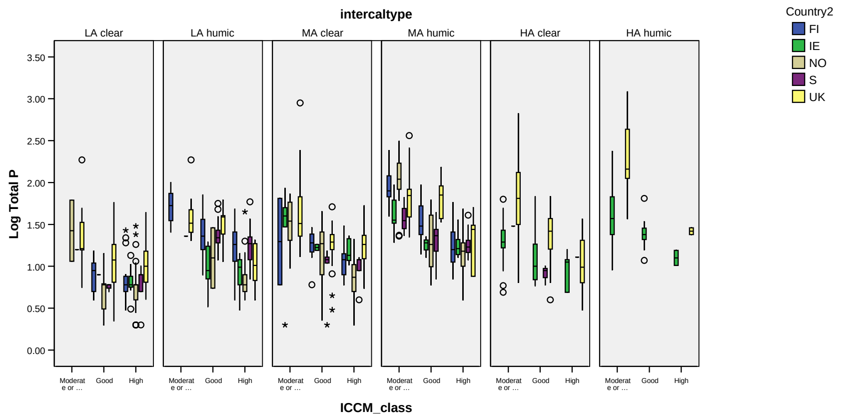


Fig C-7-1 Range of total phosphorus (log10 µg/l) for each lake type, macrophyte class (based on the ICCM) and country in NGIG.

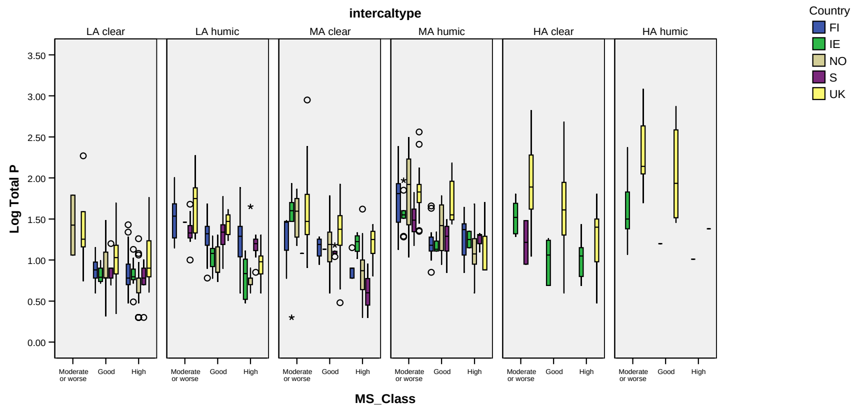


Fig C-7-2 Range of total phosphorus (log10 µg/l) for each lake type, macrophyte class (based on member state classification) and country in NGIG.

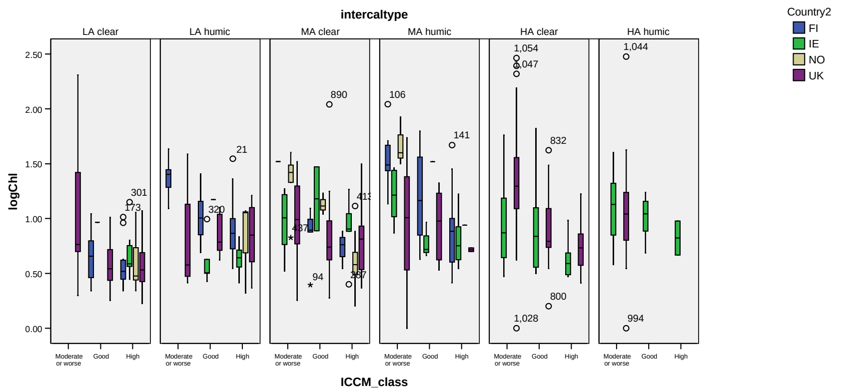


Fig C-7-3 Range of chlorophyll a (log_{10}µg/l) for each lake type macrophyte class (based on ICCM) and country in NGIG

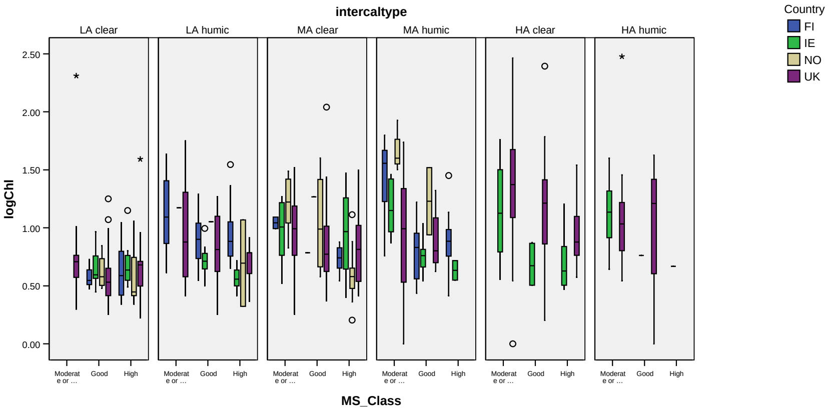


Fig C-7-4 Range of chlorophyll a ($\log_{10}\mu g/l$) for each lake type macrophyte class (based on member state classification) and country in NGIG

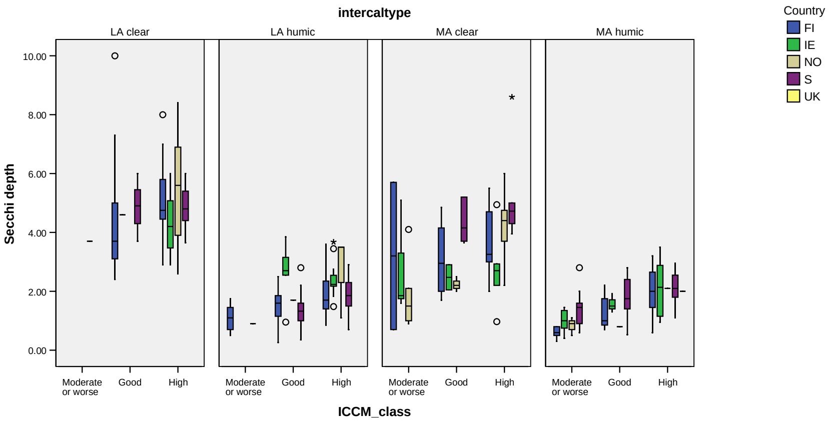


Fig C -7-5 Range of secchi depth (m) for each lake type, macrophyte class (based on ICCCM) and country in NGIG

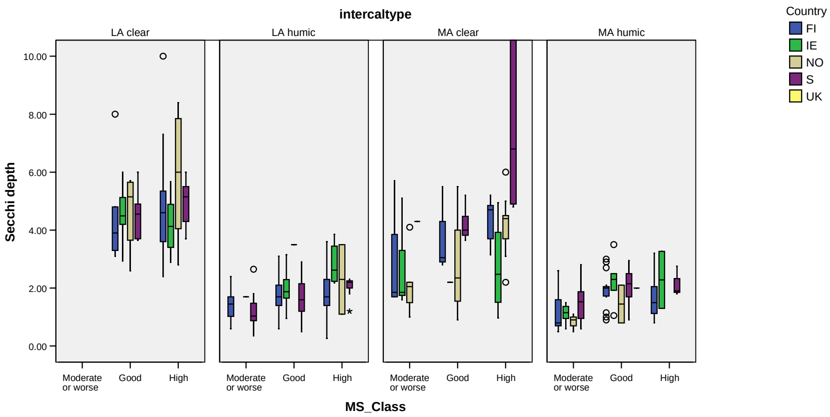


Fig C-7-6 Range of secchi depth (m) for each lake type, macrophyte class (based on member state classification) and country in NGIG

Annex C – Part 8 - Intercalibration of the water quality element of macrophytes – a comparision between Sweden and the N-GIG

Background

For the N-GIG intercalibration of the water quality element of macrophytes, macrophyte data from 119 lakes were included. Most of these lakes (*n*=71) belong to the Swedish typology group 2, i.e. lakes north of Limes Norrlandicus (LN) and below the highest coastline (HC) (Table C-8-1). The Swedish typology types do not correspond to the intercalibration types (Table C-8-1). Most of the Swedish lakes (*n*=74) belong to the intercalibration types 102 and 202, i.e. humic lakes.

Table C-8-1. The number of lakes included in the intercalibration divided by N-GIG and Swedish typology.

Swedish typology	N-GIG intercalibration type					Number of lakes
	101	102	201	202	301	
1 (N of LN, aHC)	7	8	4	6	0	25
2 (N of LN, bHK)	2	41	4	20	4	71
3 (S of LN)	3	3	4	13	0	23
Number of lakes	12	52	12	39	4	119

Correlation between the Swedish and N-GIG EQRs

The EQRs according to the Swedish metric and the intercalibration metric (IM) are highly correlated ($p<0.001$) when neglecting typology groups (Figure 1). Generally, EQRs from the IM are higher than from the Swedish metric (Figure C-8-1). Dividing the dataset by the Swedish typology groups shows that correlations are significant except for typology group 3, lakes south of LN (Figure C-8-2). However, the number of intercalibrated lakes in the Swedish typology group 3 are rather small (*n*=23). Also when dividing the dataset by the Swedish typology groups reveals that IC EQRs from the IM are higher than from the Swedish metric

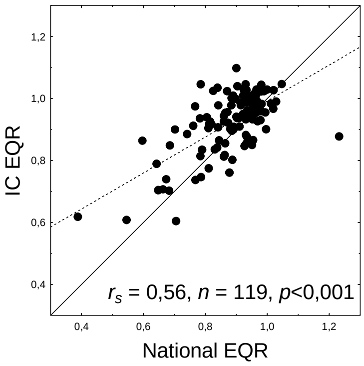
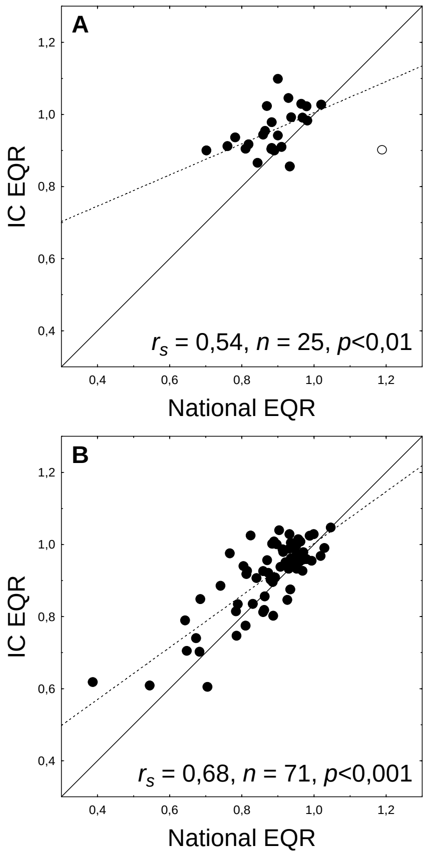


Figure C-8-1. Relationship between the Swedish EQRs (National EQR) and intercalibration EQRs (IC EQR) including all Swedish typology groups (1-3). Spearman's rank correlation coefficient (r_s), linear regression line (dotted) and theoretical regression line (optimal agreement between the Swedish EQRs and the IC EQRs) are given.



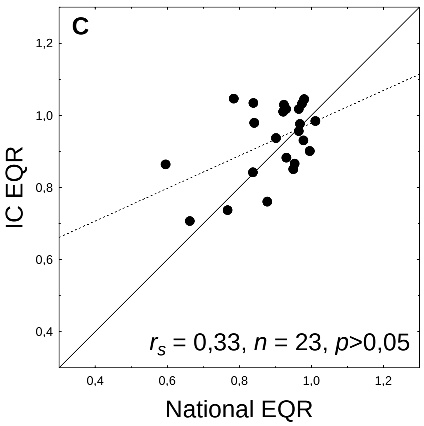


Figure C-8-2. Correlation between the Swedish EQRs (National EQR) and intercalibration EQRs (IC EQR) for the Swedish typology group 1 (A, N of Limes Norrlandicus, above Highest Coastline), group 2 (B, N of Limes Norrlandicus, below Highest Coastline) and group 3 (C, S of Limes Norrlandicus). Spearman's rank correlation coefficient (r_s), linear regression line (dotted) theoretical regression line (optimal agreement between the Swedish EQRs and the IC EQRs) are given. In the analysis of group 1 one outlier (red circle) was excluded.

Comparison of classification of ecological status between the IC and Swedish system

Classification of ecological status differed significantly between the IC and Swedish system if all typology types were combined (Table C-8-2). The difference was still significant if status classification was reduced to HG (high, good) and MP (moderate, poor) (Table 3). Comparing the two systems reveals that classification according to the Swedish system is more restrictive. For example were 24 lakes (20.2%) classified as H or G according to IC but to M or P according to the Swedish system (Table C-8-2, C-8-3). Conversely, only 2 of 119 lakes (1.7 %) were classified as G according to the Swedish system but as M according to IC (Tabele 2, 3).

Table C-8-2. Number of lakes in the different classes of ecological status according to the IC and Swedish system (Pearson Chi-square: 49,36, $df = 6$, $p<0,001$). For IC, the classes M and P were combined to the M-class.

Status (Swedish system)	Status (IC)			Number of lakes
	H	G	M	
H	12	5	0	17
G	34	31	2	67
M	2	15	3	20
P	1	6	8	15
Number of lakes	49	57	13	119

Table C-8-3. Number of lakes in the HG and MP classes of ecological status according to the IC and Swedish system (Pearson Chi-square: 21,42, *df* = 1, *p*<0,001). For IC, the classes M and P were combined to the M-class.

Status (Swedish system)	Status (IC)		Number of lakes
	HG	MP	
HG	82	2	84
MP	24	11	35
Number of lakes	106	13	119

Dividing the dataset by the Swedish typology types reveals that the most pronounced differences between IC and the Swedish classification are found in typology type 2 (N of LN, bHC (Table C-8-4,5,6). Also here, the Swedish classification is more restrictive than the IC classification.

Table C-8-4. Number of lakes of Swedish type 1 (N of LN, aHC) in the different classes of ecological status according to the IC and Swedish system (Pearson Chi-square: 5,47, *df* = 3, *p*>0,05). For IC, the classes M and P were combined to the M-class.

Status (Swedish system)	Status (IC)		Number of lakes
	H	G	
H	3	1	4
G	7	9	16
M	0	4	4
O	0	1	1
Number of lakes	10	15	25

Table C-8- 5. Number of lakes of Swedish type 2 (N of LN, bHC) in the different classes of ecological status according to the IC and Swedish system (Pearson Chi-square: 42,11, *df* = 6, *p*<0,001). For IC, the classes M and P were combined to the M-class.

Status (Swedish system)	Status (IC)			Number of lakes
	H	G	M	
H	7	3	0	10
G	19	15	1	35
M	1	11	1	13

O	1	4	8	13
Number of lakes	28	33	10	71

Table C-8-6. Number of lakes of Swedish type 3 (S of LN, bHC) in the different classes of ecological status according to the IC and Swedish system (Pearson Chi-square: 10,78, $df = 6$, $p > 0,05$). For IC, the classes M and P were combined to the M-class.

Status (Swedish system)	Status (IC)			Number of lakes
	H	G	M	
H	2	1	0	3
G	8	7	1	16
M	1	0	2	3
O	0	1	0	1
Number of lakes	11	9	3	23

Discussion

The correlation between the ERQs from IC and the Swedish system is high, considering that the IC typology differs entirely from the Swedish typology (water quality-based *versus* geographically-based). Non-significant correlations are probably a result of small sample size and a mixture of IC types per Swedish typology type. The outcome of the classification of ecological status differs between the IC and Swedish system. However, the Swedish system is more restrictive than the IC system.

For Sweden, it is not practicable to adopt the IC typology since necessary water quality data (alkalinity and color) are missing for most of the lakes with macrophyte data. For IC, the IC types were partly interpolated from co-variables (e.g. color from Secchi depth). Such procedure might result in low accuracy.

Considering the restrictiveness of the Swedish classification of ecological status and the restricted availability of water quality data for classification of lakes according to IC typology, Sweden argues for keeping its national typology and its national system for the ecological quality element of macrophytes.

Annex C – Part 9 Varying geographical and climatic conditions

1) Varying geographical conditions inside the N GIG area.
    a) In Finland and in eastern parts of Middle and Northern Sweden the bedrock is very old, whereas in Norway the bedrock is mostly younger. This has implications for the water quality.
    b) High relief in the western part, low in the eastern part. This difference influences significantly the conditions in surface waters.
    c) Overall retention of water in river basins is longer in the eastern than in the western parts of the NGIG area. Retention time of lakes varies a lot, mostly due to topographic and climatic differences. Norwegian lakes have, for example, generally shorter retention time than lakes in Sweden and Finland.
    d) Coverage of mires is significant in the eastern part, especially to the east and north of the Gulf of Bothnia in Finland and in parts of Northern Sweden.
    e) There are significant differences in macrophyte species composition between different countries and several subatlantic species are not growing in northern part of Finland.

2) Climate
    a) The duration of winter varies. In the Scandinavian countries the period of ice coverage is usually from 4 to more than 6 months, whereas in Great Britain from 0-1 month. Thus, the growing season in the north is usually from May to September/October, in the southern parts longer.
    b) In all the Scandinavian countries the north-south climate gradient affects the growing season to a large extent. Lakes in the Northern boreal areas have shorter growing seasons and lower mean water temperatures during the growth season.

3) Differences in monitoring methods and available data
    a) All countries are providing whole-lake data which means that especially in large lakes can exit several different habitats with different species composition.
    b) Sampling methods/ representativeness of data can vary significantly.
    c) Quality of water quality data differs and in most of the cases it is not taken simultaneously with macrophyte survey.