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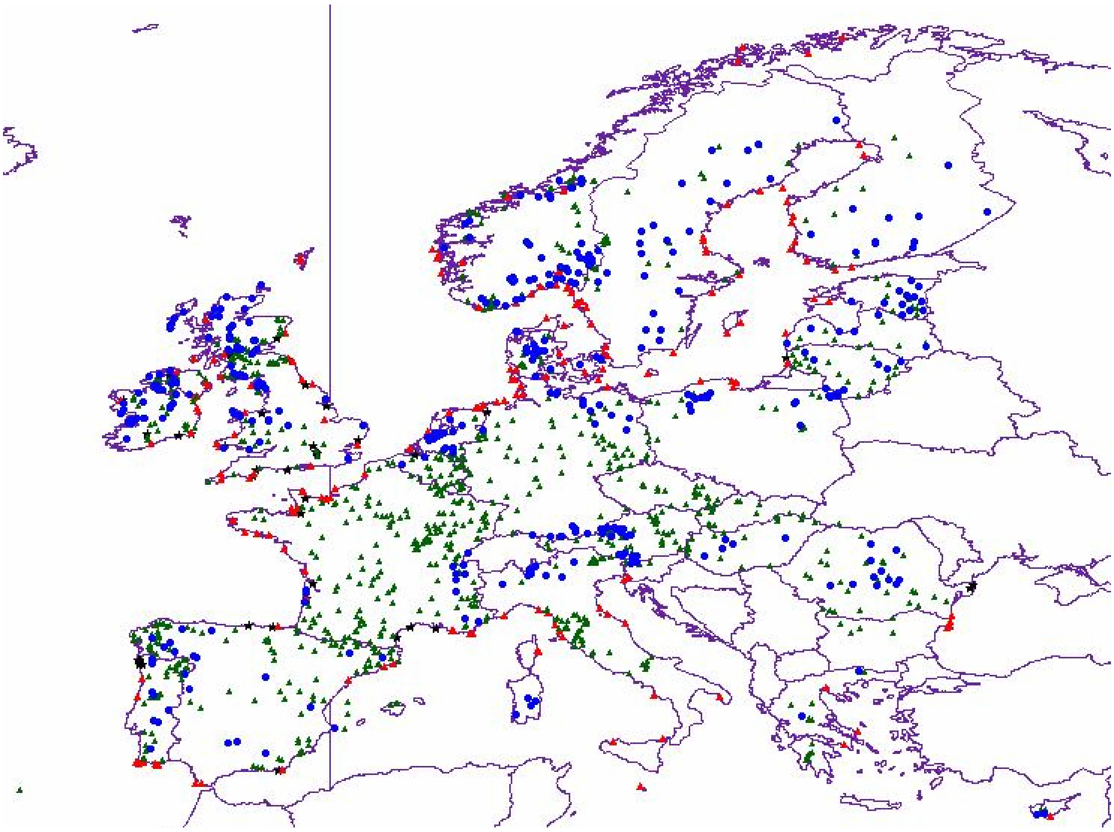
THE WATER FRAMEWORK DIRECTIVE FINAL INTERCALIBRATION REGISTER FOR LAKES, RIVERS, COASTAL AND TRANSITIONAL WATERS: OVERVIEW AND ANALYSIS OF METADATA



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SUMMARY

By October 2004, the Final Intercalibration Register was successfully established following the procedure described in the Intercalibration guidance[1] document agreed by the Water Directors in December 2002. In order to evaluate the consistency of the Register with the Water Framework Directive (WFD) provisions and the comparability of sites presented for intercalibration, the Joint Research Centre (JRC) carried out an in-depth analysis based on metadata electronically submitted to the European Commission via the Web Upload System established by the JRC for the compilation of the Intercalibration Register (http://wfd-reporting.jrc.cec.eu.int/). In November 2004, the Intercalibration Register contained 1500 surface water sites from 27 countries. Rivers were represented by the biggest number of sites (883) followed by lakes (385), coastal waters (190) and transitional waters (42). The following aims were set for the analysis of the Intercalibration Register:

1. to evaluate the sufficiency of number of sites representing the high/good and good/moderate quality class boundaries in different types;
2. to evaluate if the type characteristics of the selected sites followed the agreed criteria for the type they are submitted for (including evaluation of possible outliers);
3. to summarise the availability of data for specified biological, physicochemical and other quality parameters regarding also the length of the time-series and sampling frequency;
4. to analyse differences of pressures along the indicated quality class gradient;
5. to analyse the availability of reference conditions and the methods used to establish them.

The intercalibration exercise should be carried out for all agreed common intercalibration types for which it was agreed to have a minimum number of five sites per type and per quality class boundary[1]. Each type should be shared at least between two countries (i.e. at least two or more countries should submit sites for each common type). Most of the river (94%) and lake (88%) types and quality class boundaries had

[1] Common Implementation Strategy for the Water Framework Directive (2000/60/EC). Guidance Document No. 6. European Communities, 2003. Electronic document. Available at: http://forum.europa.eu.int/Public/irc/env/wfd/library

a sufficient number of sites. However, for coastal, and especially in transitional waters, several types and quality boundary groups had only one site. The sharing criterion (types should be shared by at least two countries, which all should have submitted sites for this type) was fulfilled in most cases, if sufficient number of sites was selected for the type in question. According to the Guidance on the Intercalibration Process[2], the Intercalibration network will be directly used only in the process option 3 and, perhaps, also in some hybrid options in which national methods will be directly compared at intercalibration sites. Hence, the Geographical Intercalibration Groups (GIGs) planning to use option 3, should look for possibilities to use test sites beyond the current Intercalibration Register.

During the site submission, the countries were asked to provide information on the data availability from the selected sites. For lakes the largest amount of data was available on phytoplankton and in rivers on benthic macroinvertebrates. In coastal and transitional waters both quality elements were nearly equally represented in the database. As there is an obvious lack of data for several other biological quality elements required for a WFD compliant ecological water quality assessment and as the time constraints of the exercise do not allow a substantial improvement of data availability, the results of intercalibration will be valid exclusively for those classification systems based on the quality elements that will be included in the exercise. However, a need to revise the intercalibration network may arise when new data becomes available for additional quality elements after the monitoring system will be operational in 2007.

In order to check the consistency of sites with the agreed criteria for the common types, information was also asked on the site-specific values of some type parameters. Regarding the agreed ranges of typology parameters[3] the analysis revealed altogether 764 outlying values. Altogether, outliers were found in the data of 542 sites: 304 rivers, 96 lakes, 119 coastal and 23 transitional water sites. On average, more than 1/3 of all sites submitted to the Intercalibration Register deviated to some extent from the agreed type descriptions. Among those sites 131 deviated by two parameters, 26 sites

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[2] WG2A/27281004/5/d. Available at http://forum.europa.eu.int/Members/irc/env/wfd/library

[3] *Overview of common intercalibration types and guidelines for the selection of intercalibration sites.* Version 4.0, Feb. 26, 2004. Available at http://forum.europa.eu.int/Members/irc/env/wfd/library

by three parameters, and in the case of 13 coastal water sites even four parameters were outside of the agreed ranges.

Despite the large number of outliers (i.e. sites that deviated to some extent from the agreed common intercalibration types), this is in general not a critical issue for the intercalibration exercise: in most cases the deviations from the agreed ranges were very minor and most likely the sites selected still belong to the same common intercalibration type, allowing comparisons of assessment results using data from these sites. The relatively large number of outliers among coastal and transitional sites (more than 60% fell outside the type description) seems to be caused by the combination of a large number of narrowly defined type criteria. In order to assist the Member States in GIGs to distinguish sites, which are really incomparable (i.e. definitely do not belong to the same common type) and to find out erroneous entries in the database, the lists of potential outlier sites is presented in Appendix 1.

All three options for the intercalibration exercise (as well as any hybrid options) require agreement on principles to derive type-specific reference conditions, and the establishment of data sets illustrating gradients of biological alteration, if possible along a pressure gradient, and at least including the two relevant class boundaries. During the site submission, the countries were asked to indicate the strength of the major pressures that potentially impacted the selected sites, using qualitative scale of 0-4. These pressures could be divided into three groups: pollution pressures, disturbance pressures, and morphological alteration pressures. The qualitative evaluation of the different pressures indicated that all pressures were potentially strongest for transitional water sites followed by sites from coastal waters, lakes, and rivers. For all water categories the total pollution pressure was indicated to be the strongest. The sites selected to represent the high/good boundary were mostly indicated to have very low pollution pressures, and the good/moderate boundary sites were indicated to have low pollution pressures. The disturbance pressures were generally rather marginal remaining below 1 (weak) for 75% of lakes and rivers even in the moderate quality class..

Numeric values of parameters reflecting water quality were submitted only for lakes (Secchi depth, chlorophyll concentration, total phosphorus). These values were used to study the dependence of the quality parameters on the mean depth of the lakes. It appeared that shallow and deep lakes differ significantly with respect of the water quality parameters, and should be considered as separate groups in any further analysis.

The establishment of reference conditions is the first step in the intercalibration exercise. During the site submission it was asked if reference conditions were already established for the selected sites. It appeared, that at least for some quality elements, reference conditions were established already for 77% of lakes, 65% of rivers, 29% of coastal water sites and 21% of transitional water sites. Quality element specific reference conditions were mostly available for total phosphorus and chlorophyll in lakes, for benthic macroinvertebrates in rivers, for nutrients and benthic invertebrates at coastal sites and for temperature and salinity at transitional water sites. For lakes and rivers, reference conditions were most often established based on comparison with existing reference sites, secondly using expert opinion and finally using historical data or modelling. In the case of transitional and coastal waters historical data was most frequently used followed by expert opinion and modelling for establishment of the reference conditions..

The intercalibration exercise will result in the identification of sites representing the ecological quality boundary conditions among the sites in the intercalibration network. The current Register provides a good starting point for this process, particularly for the inland waters. For coastal and transitional waters the the number of sites is more restricted, but probably will still allow comparison of national classification tools, if data from additional test sites can be used during the process. As one of the aims of the intercalibration process is to establish a network of European surface water sites which fulfil the common criteria for good and high ecological quality, it is most likely that some changes for the current Register of the intercalibration network will be proposed.

1. Introduction

The Directive 2000/60/EC ("Water Framework Directive"; WFD) requires that Member States establish monitoring and assessment systems for classification of the ecological status of their surface waters. To ensure the comparability of biological monitoring results across the ecoregions of the Community, the Directive has prescribed an intercalibration exercise of the assessment systems. The Intercalibration exercise is divided into two phases, the first of which is the establishment of an intercalibration network in 2003-4:

*… Within three years of the date of entry into force of the Directive, the Commission shall prepare a **draft register of sites** to form the intercalibration network, which may be adapted in accordance with the procedures laid down in Article 21. The **final register of sites** shall be established within four years of the date of entry into force of the Directive and shall be published by the Commission.*

The present report is aimed to give an overview of the Final Register of sites selected by the Member States during 2003-2004 (further referred to as Register). After submission of the Register to the Strategic Co-ordination Group in October 2004, the Joint Research Centre (JRC)carried out an analysis based on metadata submitted for the sites in order to evaluate the composition and quality of the Register. The aims of this analysis were:

1. To describe the structure of the Register in terms of the distribution of the sites between countries, surface water categories, Geographic Intercalibration Groups (GIGs), and common intercalibration types agreed to be focussed on[4];
2. To evaluate if the numbers of sites representing the high-good and good-moderate quality class boundaries in different water body categories and types are sufficient to carry out the intercalibration exercise in 2005-06;
3. To summarise the availability and amount of monitoring data for biological and physicochemical quality elements;
4. To summarise the availability of reference conditions for biological and physicochemical quality elements and the methods used to establish them;

[4] *Overview of common intercalibration types and guidelines for the selection of intercalibration sites.* V.4.0 26.02.2004 available at http://forum.europa.eu.int/Members/irc/env/wfd/library

5. To evaluate the compliance of the sites with the agreed criteria for the types they were submitted for and to indicate outliers that do not comply.

In the following part we list the main milestones that have lead to the finalisation of Register:

In November 2003, the **Draft Register of sites** for intercalibration was successfully established following the procedure described in the Intercalibration guidance document[5] agreed by the Water Directors in December 2002. The Draft Register was analysed by the JRC (Nõges et al., 2004) based on metadata submitted electronically to the European Commission via the Web Upload System established by the JRC for the compilation of the Draft Intercalibration Register (http://wfd-reporting.jrc.cec.eu.int/) by January 2004. At that time, the Draft Intercalibration Register contained 1075 sites from 25 countries of all three surface water categories: rivers (653), lakes (314), coastal waters (83) and transitional waters (25).

In February 2004, Expert networks for Lakes, Rivers and Coastal and Transitional Waters met to identify revisions needed for the intercalibration network:

- Revision of the geographical intercalibration groups
- Revision of the common intercalibration types, pressures and quality elements
- Identification of the data requirements for the intercalibration sites (which data can be shared and which new data needs to be collected)
- Revisions for the metadata questionnaire for the final submission/ removal of sites for the intercalibration network

In March 2004, the Common Implementation Strategy Working Group 2A Ecological Status agreed on the revisions proposed by the Expert Networks and a new version of the metadata questionnaire was sent by the JRC to the members of the Working Group 2A and the Expert Groups.

[5] *Towards a Guidance on Establishment of the Intercalibration Network and the Process on the Intercalibration Exercise*. CIS Guidance Document No 6. Produced by Working Group 2.5 – Intercalibration. European Communities, 2003. Available at: http://forum.europa.eu.int/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/

In April 2004, the revised web-based metadata entry was opened (http://wfd-reporting.jrc.cec.eu.int/) allowing Member States to add/remove/revise intercalibration site entries.

In May 2004 EC - DG Environment and JRC prepared the draft decision on the Final Register of Intercalibration Network for the Strategic Co-ordination Group and the Water Framework Directive Committee (Article 21 Committee). At the Committee meeting on 28.05.04, the JRC presented a Progress on Intercalibration Register and Intercalibration Process, including an overview of the sites submitted for each of the water categories (lakes, rivers, coastal and transitional waters) by the agreed deadline of 24 May 2004. The Committee invited Member States, which had not submitted sites by May (i.e. Malta) to do so in order to ensure consistency across Europe or to confirm in writing if they do not have water bodies of some category. The deadline for finalising the Register by electronic submission/deleting of information on the sites was set on 15 September 2004.

From June to September 2004, the metadata entry was reopened to allow revisions needed to finalise the Register according to the comments made by the Strategic Co-ordination Group (SCG) and the Water Framework Directive Committee.

In October 2004, the Register together with the Draft Commission Decision was submitted to SCG and WFD Committee. After being adapted by the Committee who has given their final comments on the text on 28 October, these documents entered the inter-service consultation of the Commission via DG Environment.

The sites forming the intercalibration network will be published as a part of the **Decision on the Final Register of Intercalibration Network** that will finish the first stage of the intercalibration process in 2005. This Decision, jointly prepared by DGENV and JRC, contains some recitals on the possibility for reviewing the Intercalibration Register in the future, particularly taking into account the results of the intercalibration exercise and possibly also during the initial steps of the River Basin Management Plan revision. These recitals reflect the outcome of the last few year's discussions in the Intercalibration/Ecological Status working group, Strategic Co-ordination Group, and Water Directors stressing the limitations of the present intercalibration exercise and the need for further work after 2006.

2. General description of the Final Intercalibration Register

The intercalibration network includes a limited number of water body types consisting of sites representing boundaries between quality classes ‘high’-‘good’ and ‘good’-‘moderate’, based on the normative definitions in the Annex V (section 1.2) of the Directive (2000). The Directive requires the selection of these sites be carried out “using expert judgement based on joint inspections and all available information”

The following information is given for each site in the Register:

- Country by country code (Table 2.1);
- Name of the site;
- Geographical Intercalibration Group (Table 2.2);
- Common Intercalibration type, where the site belongs to (Table 2.2);
- Boundary the site most closely represents (high-good (HG) or good-moderate (GM)), according to Member States assessment of the ecological quality status

Table 2.1. *ISO 3166 two-letter codes of countries, which submitted sites to the Draft Intercalibration Register by November 2003*

Country	*Two-letter code*
AUSTRIA	AT
BELGIUM	BE
BULGARIA	BG
CYPRUS	CY
CZECH REPUBLIC	CZ
DENMARK	DK
ESTONIA	EE
FINLAND	FI
FRANCE	FR
GERMANY	DE
GREECE	GR
HUNGARY	HU
IRELAND	IE

Table 2.1.Continued

Country	*Two-letter code*
ITALY	IT
LATVIA	LV
LITHUANIA	LT
LUXEMBOURG	LU
NETHERLANDS	NL
NORWAY	NO
POLAND	PL
PORTUGAL	PT
ROMANIA	RO
SLOVAKIA (Slovak Republic)	SK
SLOVENIA	SI
SPAIN	ES
SWEDEN	SE
UNITED KINGDOM	GB

Table 2.2. *Geographic intercalibration groups (GIGs) and common intercalibration types of lakes, rivers, coastal and transitional waters for which sites were submitted to the Final Intercalibration Register*

Geographic intercalibration group (GIG)	**Common intercalib-ration type**	**Short description of the type**
Atlantic GIG for lakes (LAT)	***L-A1***	Lowland, shallow, calcareous, small
	L-A2	Lowland, shallow, calcareous, large
	L-A3	Lowland, shallow, peat, small
Alpine GIG for lakes (LAL)	***L-AL3***	Lowland or mid-alt., deep, mod. to high alk. (alpine influence), large
	L-AL4	Mid-altitude, shallow, mod. to high alk. (alpine influence), large
Central/Baltic GIG for lakes (LCE)	***L-CE1***	Lowland, shallow, stratified, calcareous
	L-CE2	Lowland, very shallow, calcareous
	L-CE3	Lowland, shallow, siliceous, vegetation dominated by Lobelia
Mediterranean	***L-M5***	Reservoirs, deep, large siliceous, lowland

Table 2.2. Continued

GIG for lakes (LME)	***L-M7***	Reservoirs, deep, large, siliceous, mid-altitude.
	L-M8	Reservoirs, deep, large, calcareous, between lowland and highland
Nordic GIG for lakes (LNO)	***L-N1***	Lowland, shallow, siliceous, moderate alkalinity, large.
	L-N2a	Lowland, shallow, siliceous, low alkalinity, large.
	L-N2b	Lowland, deep, siliceous, low alkalinity, large.
	L-N3	Lowland, shallow, peat, large
	L-N5	Boreal, shallow, siliceous, low alkalinity, large
	L-N6	Boreal, shallow, peat, large
	L-N7	Highland, shallow, siliceous, low alkalinity, large
Alpine GIG for rivers (RAL)	***R-A1***	Pre-alpine, small to medium, high altitude calcareous
	R-A2	Alpine, small to medium, high altitude, siliceous
Central/Baltic GIG for rivers (RCE)	***R-C1***	Small, lowland, siliceous, sand
	R-C2	Small, lowland, siliceous, rock
	R-C3	Small, mid-altitude, siliceous
	R-C4	Medium, lowland, mixed
	R-C5	Large, lowland, mixed
	R-C6	Small, lowland, calcareous
Eastern Continental GIG for rivers (REC)	***R-E1***	Carpathians: small to medium, mid-altitude
	R-E2	Plains: medium-sized, lowland
	R-E3	Plains: large and very large, lowland
	R-E4	Plains: medium-sized, mid-altitude
	R-E6	Danube River: middle and downstream
Mediterranean GIG for rivers (RME)	***R-M1***	Small, mid altitude
	R-M2	Medium, lowland
	R-M3	Large, lowland
	R-M4	Small/medium, Mediterranean mountains
	R-M5	Small, Mediterranean, temporary
Nordic GIG for rivers (RNO)	***R-N1***	Small, lowland, siliceous, moderate alkalinity, clear
	R-N2	Small-medium, lowland, siliceous, low alkalinity, clear
	R-N3	Small-medium, lowland, siliceous, low alkalinity, organic (humic)
	R-N4	Medium, lowland, siliceous, moderate alkalinity, clear
	R-N5	Small, mid-altitude, siliceous, low alkalinity, clear
	R-N7	Small, highland, siliceous, low alkalinity, clear
	R-N9	Small-medium, mid-altitude, siliceous, low alkalinity, organic (humic)

Table 2.2 .Continued

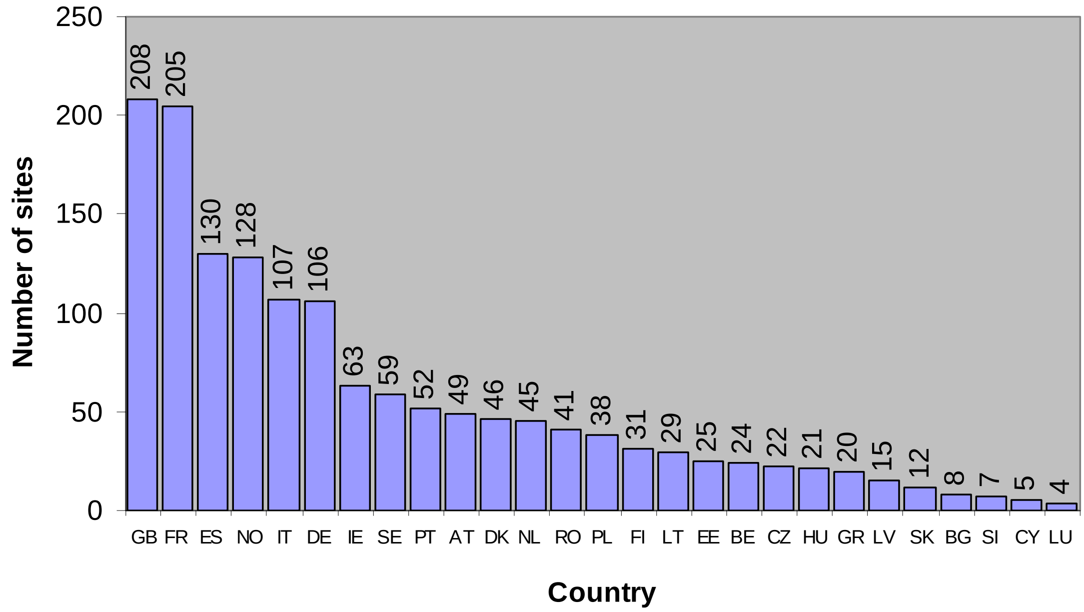
Baltic GIG for coastal and transitional waters (CBA)	***CW – B0***	Low oligohaline, shallow, sheltered, with long ice-cover
	CW - B2	High oligohaline, shallow, sheltered, with long ice-cover
	CW - B3	High oligohaline, shallow, sheltered, with medium ice-cover
	CW – B12	Mesohaline, shallow & sheltered
	CW – B13	Mesohaline, shallow & exposed
	CW – B14	Mesohaline shallow lagoons
Mediterranean GIG for coastal and transitional waters (CME)	***CW - M1***	Rocky, shallow coast
	CW - M2	Rocky, deep coast
	CW - M3	Sedimentary, shallow coast
	CTW-M4	Sedimentary, deep coast
Northeast Atlantic GIG for coastal and transitional waters (CNE)	***CW –NEA1***	Exposed, euhaline, shallow
	CW –NEA26	Sheltered, euhaline, shallow
	CW – NEA3	Polyhaline, exposed (Wadden Sea type)
	CW – NEA4	Polyhaline, mesotidal, moderately exposed (Wadden Sea type)
	CW- NEA7	Deep, low current, sheltered
	CW- NEA9	Polyhaline, microtidal, exposed, shallow (Skaggerak mid-archip. type)
	CW- NEA10	Polyhaline, microtidal, exposed, deep (Skaggerak outer archip. type)
	TW-NEA11	NE Atlantic transitional waters

By the 26th of November 2004 the meta-database of the Intercalibration Register downloaded from the database contained 1500 sites of all four surface water categories for which 27 countries (Table 1.1) had electronically submitted metadata to the JRC (Fig. 2.1) (only the intercalibration sites of Malta were missing[6]). The biggest number of sites (883) represented rivers followed by lakes (385), coastal waters (190) and transitional waters (42).

The biggest number of lakes (68) was submitted by Great Britain (Fig. 2.2). Within GIG-s the number of lakes varied from 129 (Nordic GIG) to 41 (both Alpine and Atlantic GIGs). Representatives of four countries: LU, BG, CZ, SK indicated that they have only small (<0.5 km^2) lakes and for this reason they will not participate in the lake intercalibration. The three last ones of the aforementioned countries belonged to the Eastern Continental GIG for lakes (LEC) together with parts of AT, GR, HU, RO, and SI. Initially there were 20 lake sites submitted by this GIG to the Draft Register: 14 reservoirs from Romania and six lake sites from Hungary, but as the sharing criterion was not fulfilled (comparable sites were submitted by only one

[6] Malta submitted three sites in February 2005: these sites are not included in this analysis.

country), Romania proposed to join Mediterranean GIG and Hungary withdrew the large Hungarian lakes Fertö and Balaton from the Register. In this way, the LEC stopped to exist.



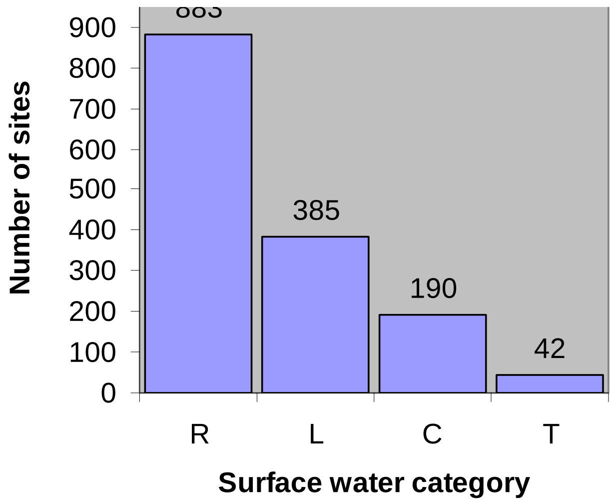


Fig. 2.1. Distribution of the total number of 1500 water body sites between countries (see abbreviations in Table 2.1) and surface water categories.

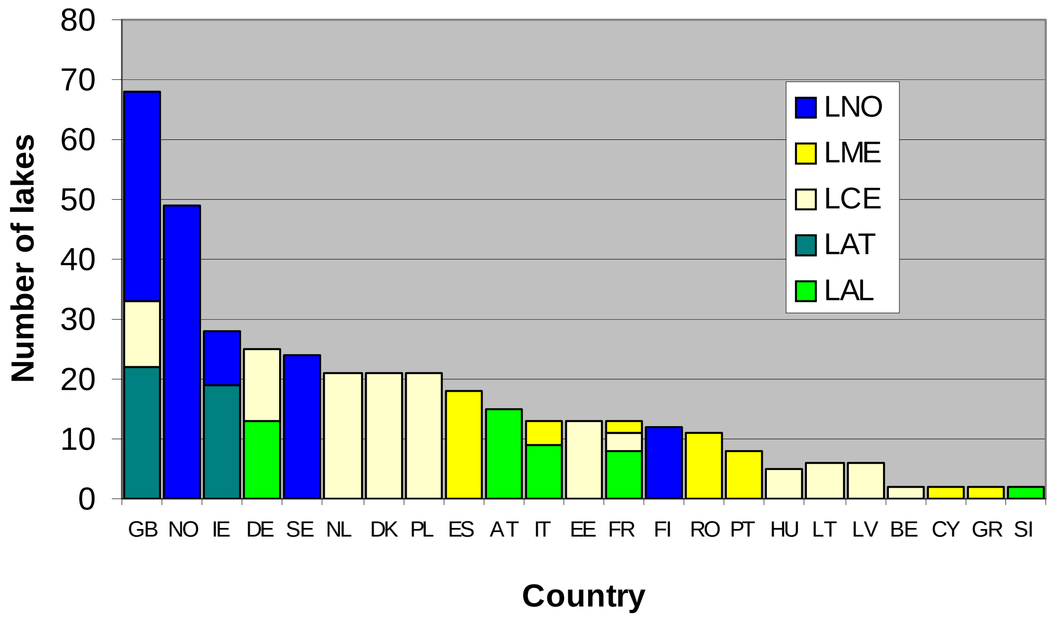
R – rivers

L – lakes

C – coastal waters

T – transitional waters

The lakes belonged to 18 types (Table 1) agreed for intercalibration (Fig. 2.3). The number of sites per type varied from 8 in L-A3 to 50 in L-CB2 (average 21). Compared with the situation in the Draft Register in January 2004, the number of types decreased from 34 to 18 mainly as a result of merging types, while the average number of sites per type more than doubled (from 9 to 21). A total of 60 lake sites, mostly from the Mediterranean and Central GIGs belonged to artificial or heavily modified waterbodies (Fig. 2.4).



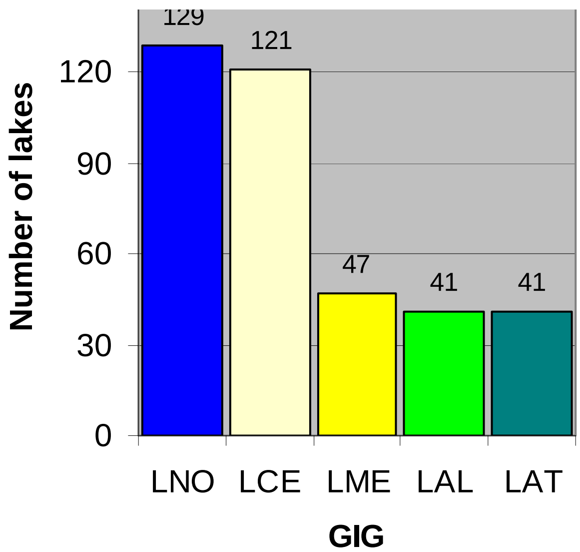


Fig. 2.2. Distribution of the lakes in the final IC register by countries and geographic intercalibration groups. For abbreviations see Tables 2.1 and 2.2.

Among rivers the biggest number of sites originated from France (160) followed by Spain (101), Great Britain (95) and Italy (79) (Fig. 2.5). Similarly to lakes, the rivers in the Final Register were divided into five GIGs, but as a difference there was no Atlantic GIG for rivers and the fifth there was the Eastern Continental GIG. Among GIGs the number of sites varied from 446 (Central GIG) to 63 (Eastern Continental GIG). The river sites were distributed between 25 types: two in the Alpine GIG, five in both the Mediterranean and the Eastern Continental GIGS, six in the Central Gig and seven in the Northern GIG (Fig.2.6). The number of sites per type varied from 9 to 120 and was 35 on the average. Thirty-three river sites belonging to three GIGs were qualified as heavily modified (Fig. 2.7).

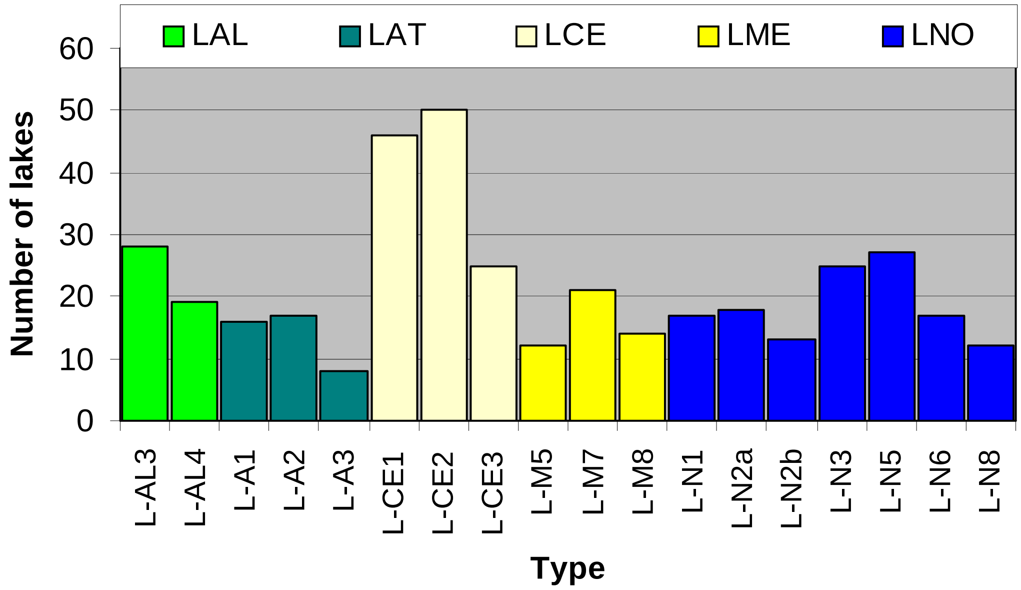


Fig.2.3. Distribution of lakes by GIGs (in different colours) and types; for abbreviations see Table 2.2

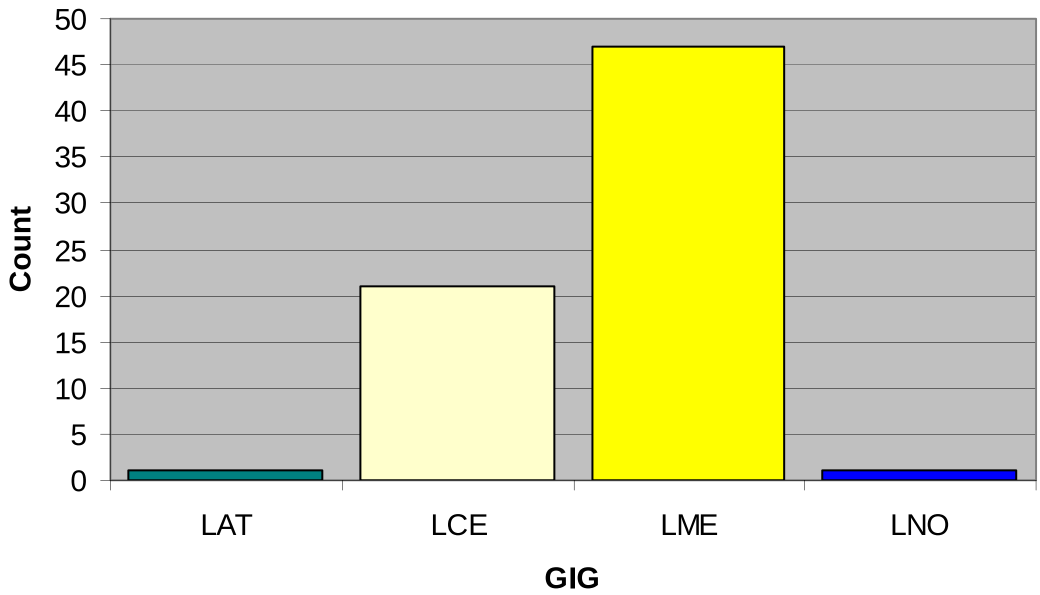
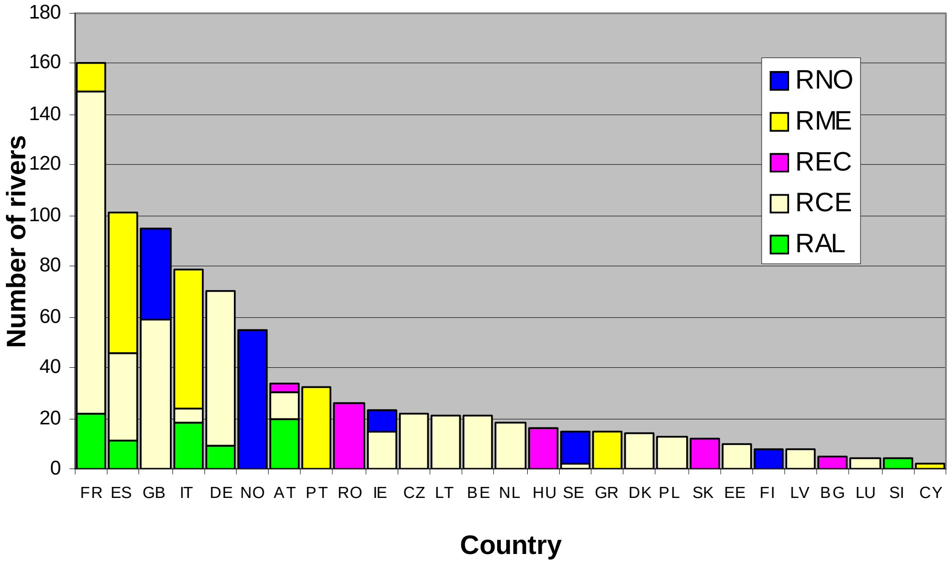


Fig. 2.4. Number of artificial/heavily modified lake sites submitted from different GIGs (see Table 2 for abbreviations) to the final intercalibration register



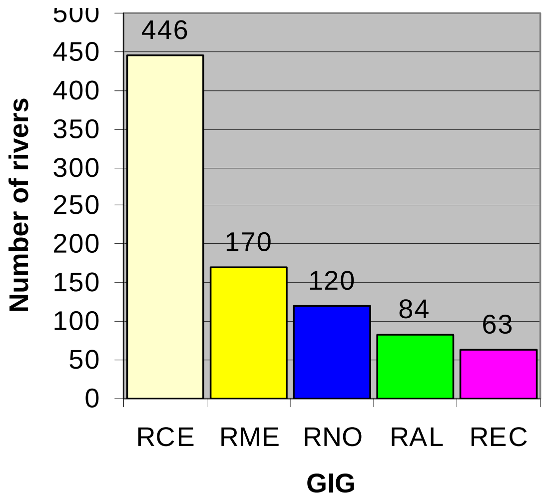


Fig. 2.5. Distribution of the rivers in the final IC register by countries and geographic intercalibration groups. For abbreviations see Tables 2.1 and 2.2

The 190 coastal water sites were divided between 21 countries and four GIGs (Fig. 2.8). Great Britain, France and Norway submitted the biggest numbers of sites. The North-East Atlantic GIG represented by 10 countries constituted nearly 2/3 of the total number of coastal sites. Thirteen of those sites were indicated as heavily modified. The smallest GIG was the Black See GIG with only one type and five sites from Bulgaria and Romania. The Baltic Sea was represented by 37 sites from eight countries and the Mediterranean Sea by 29 sites from six countries.

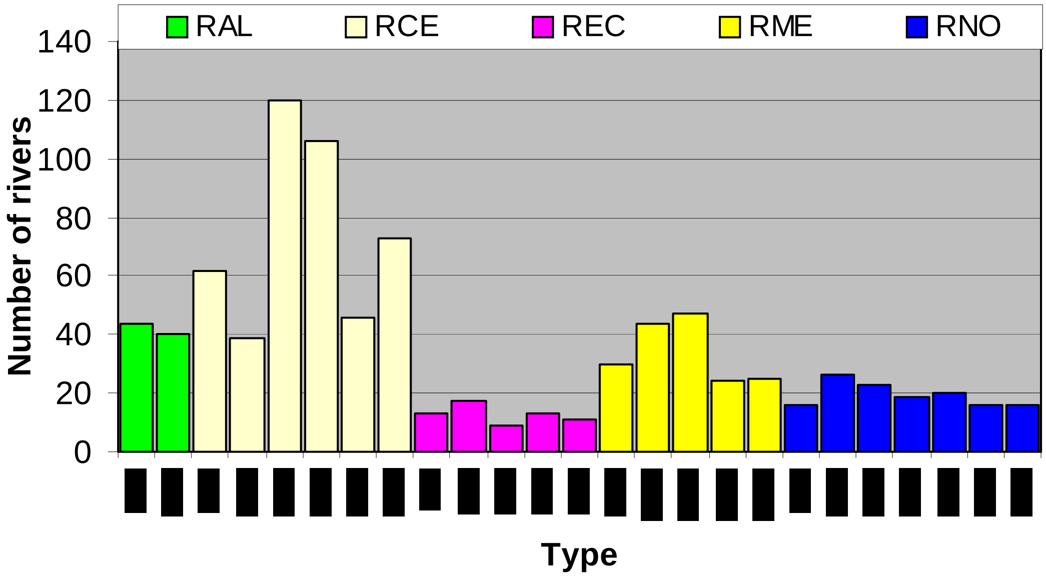


Fig. 2.6. Distribution of rivers by GIGs (in different colours) and types; for abbreviations see Table 2.2

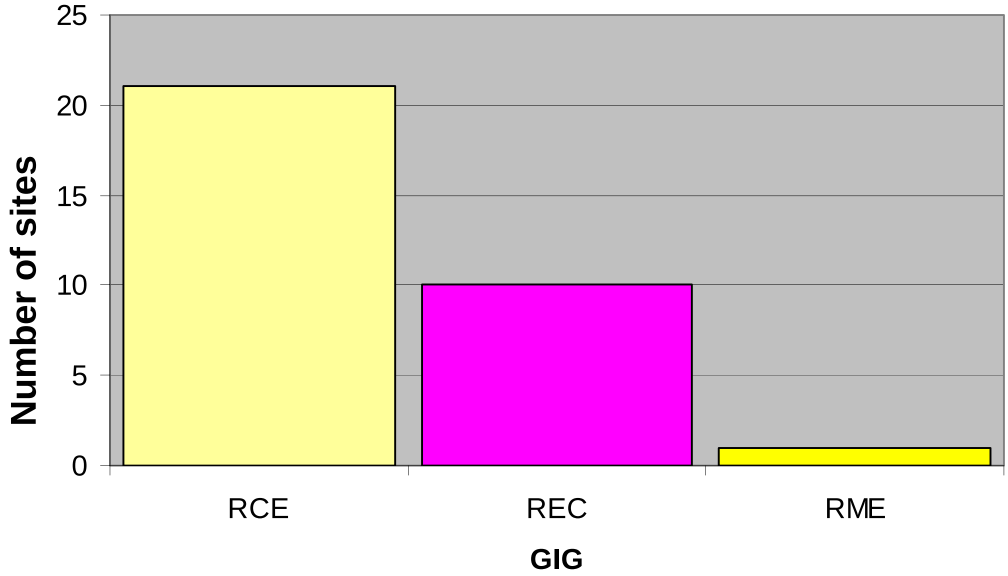
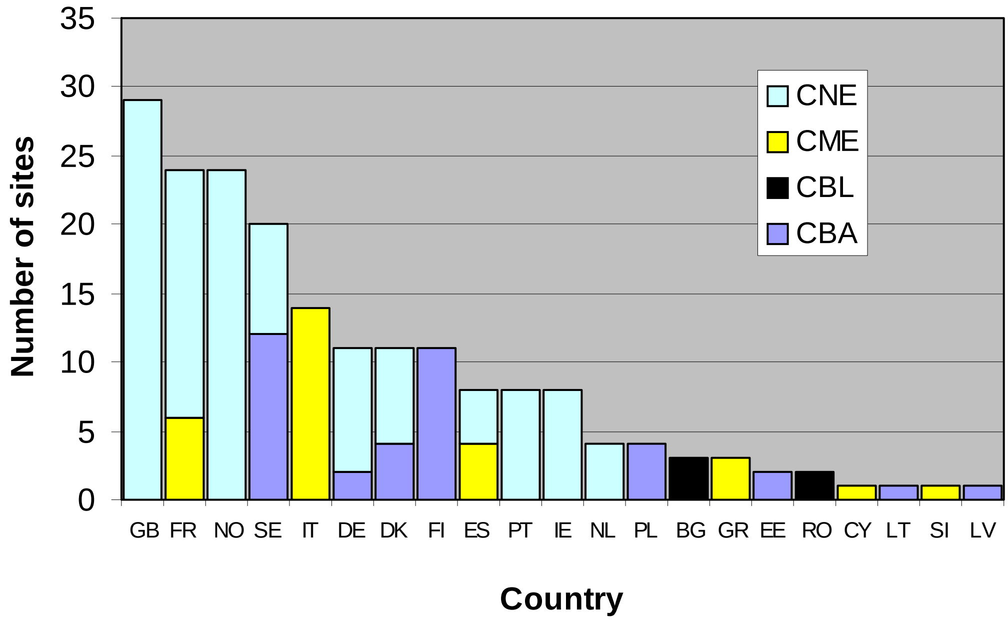


Fig. 2.7. Number of artificial/heavily modified river sites submitted from different GIGs (see Table 2 for abbreviations) to the final intercalibration register

Ten countries submitted altogether 42 sites of transitional waters to the Register (Fig. 2.10). These sites were divided into nine types belonging to four GIGs (Fig. 2.11). Although it was decided in the North-East Atlantic GIG to submit sites only to the transitional water type TW-NEA11[7], there were still two sites indicated as CW-NEA26 (Fig. 2.11). The type TW-NEA11 had by far the biggest number of sites, 32, while all other types were represented by only one or two sites. More than a half of all transitional water sites (22) were indicated as heavily modified.



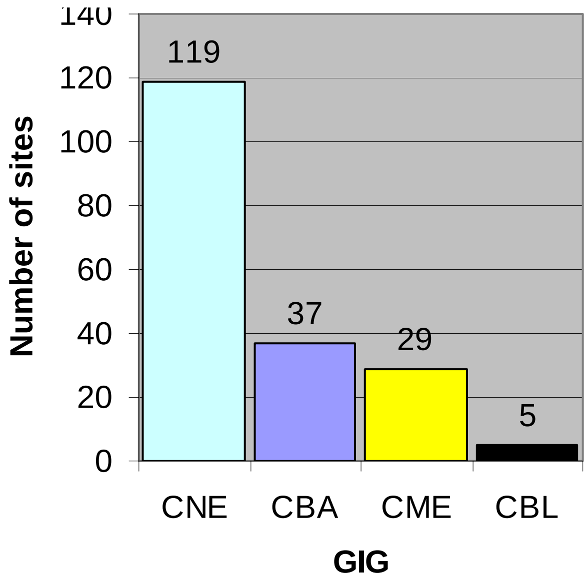


Fig. 2.8. Distribution of the coastal sites in the final IC register by countries and geographic intercalibration groups. For abbreviations see Tables 2.1 and 2.2

[7] *Overview of common intercalibration types and guidelines for the selection of intercalibration sites.* V.4.0 26.02.2004 available at http://forum.europa.eu.int/Members/irc/env/wfd/library

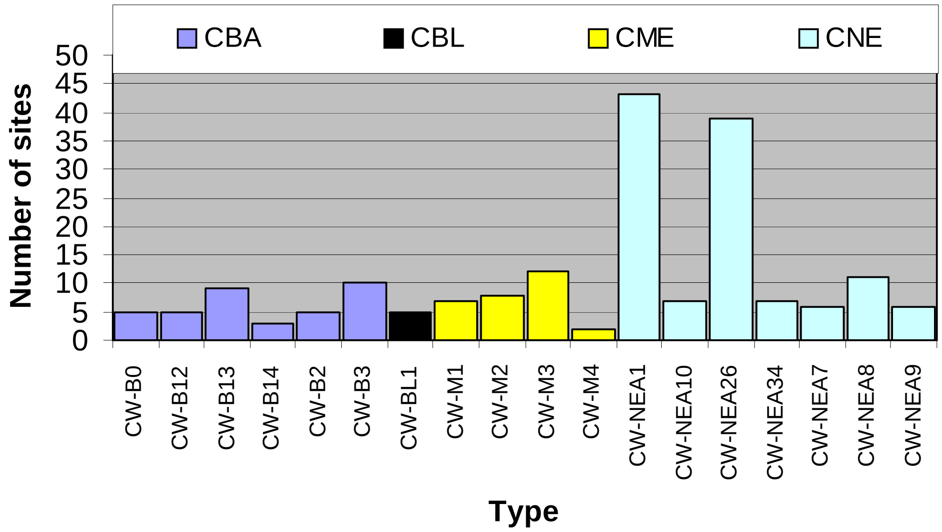
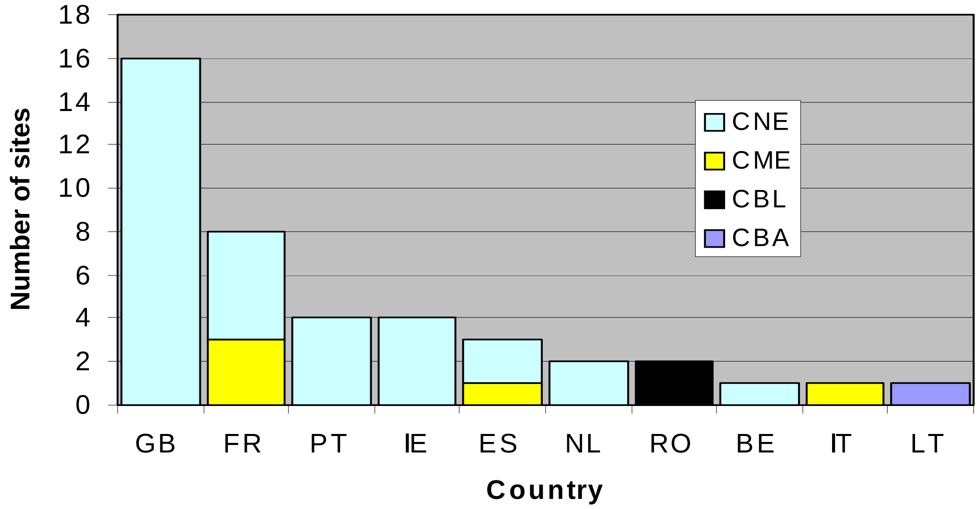


Fig. 2.9. Distribution of coastal water sites by GIGs (in different colours) and types; for abbreviations see Table 2.2



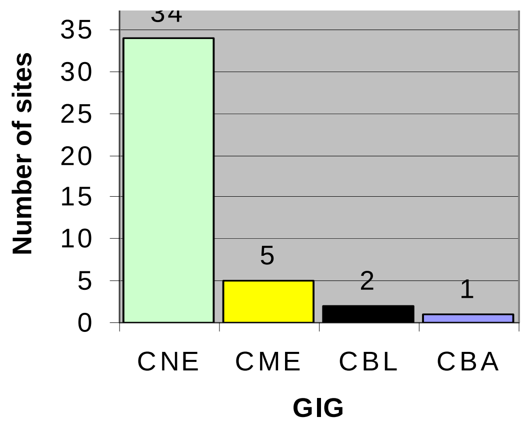


Fig. 2.10. Distribution of the transitional water sites in the final IC register by countries and geographic intercalibration groups. For abbreviations see Tables 2.1 and 2.2

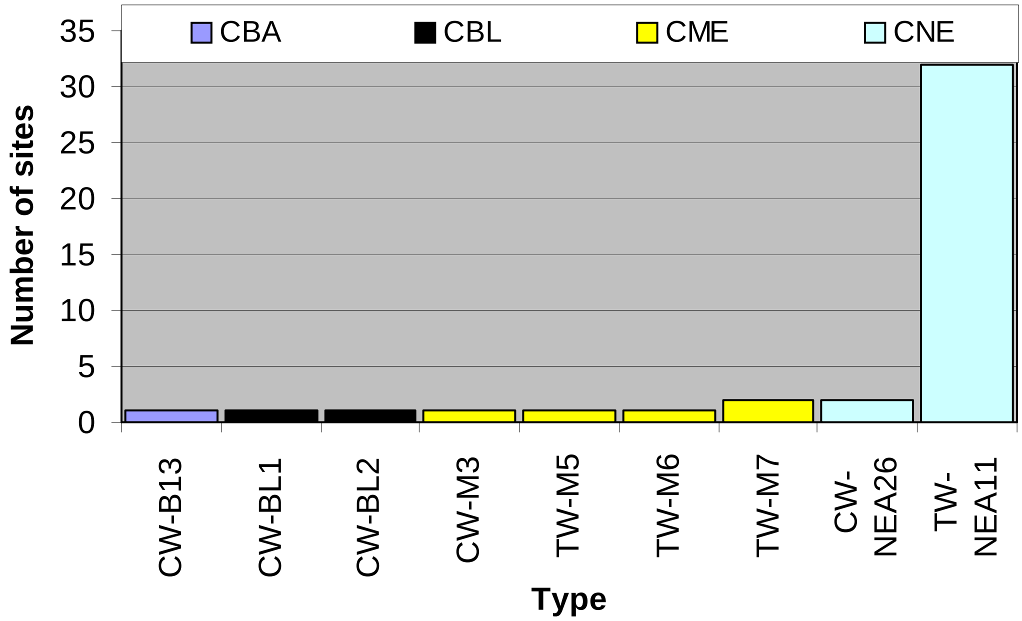


Fig. 2.11. Distribution of transitional water sites by GIGs (in different colours) and types; for abbreviations see Table 2.2

3. Methods

3.1. Corrections made to the database prior the data analysis

The new web-based data submission system opened in March 2004 replaced the previous version of the metadata questionnaire and included some additional questions. It allowed entering new sites and for sites already in the Register the existing data were visible as pre-filled forms and only the fields for additional data were empty. The new web-based system included also format checking at some level. However, the check was not sufficient to avoid all possible errors at data entry. Errors like non-corresponding couples of GIG and type names, non-numeric entries in fields that were supposed to be numeric, commas instead of decimal points and even unit errors might have been quite easily avoided at the entry level. Several fields were made mandatory but no format to indicate missing values was agreed. In order to still submit data for sites for which some mandatory values were missing, Member States introduced several dummy values, which were sometimes problematic.

After the screening of the database downloaded on the 21 November 2004, all problematic entries were communicated to the Member States and they were asked to make corrections. Still there were several inconsistencies left in the data downloaded for the present analysis on 26 November 2004. We made the corrections listed below to our file extracted from the database, prior the analysis, but **we did not introduce the corrections to the Final Intercalibration Register**, the original of which is kept in the XML format on the server at the JRC.

Wrong indication for type or GIG

- Irish transitional water site Suir Estuary Lower indicated as type CW-M1. As it was decided within the North-East Atlantic GIG, all countries identifying transitional waters should submit their sites using the type identifier TW-NEA11.
- Irish coastal site Cork harbour is indicated as belonging to type CW-NEA2. As this type does not exist anymore (it was merged with type CW-NEA6 to form the CW-NEA26), the type name was changed accordingly.
- Eleven coastal sites are still indicated as CW-NEA8 by DK, NO and SE although it was decided by the Working Group 2A to remove this type from the Register.

As no type criteria for CW-NEA8 are included to any version of the IC Type Manual, it was impossible to check this type for outliers.

- British Loch Sgealtair is indicated as belonging to Nordic GIG but to type L-A1. As UK participates in both Nordic and Atlantic GIGs for lakes, it was decided on the basis of the lake size, that the type was indicated correctly. Hence, the GIG was changed to LAT
- French lake Saint Point is indicated as belonging to the Central GIG but to the Alpine lake type L-AL3. According to the altitude (850 m) it was decided that the type was correct and the GIG was changed, accordingly.

Dummy entries

Zero values deleted in

- River catchment area (IT, FR)
- River bed width (IE, RO)
- Amount of precipitation (IT, ES, SK, IE)
- Maximum river basin altitude (IT, IE)
- River alkalinity for countries which gave only zeros (IT, IE)
- Organic matter

Other dummies:

- Coastal deep layer salinity 99.9 or 999

Non-numeric entries in numeric fields

Commas in numeric variables replaced with decimal points

Surface salinity >30 replaced with 36

Comments added to numbers in numeric fields were checked one by one. If the comment did not change the meaning of the number, the comment was removed but if it set a restriction to the number not allowing using it equally with other values in the column, the whole entry was excluded from the analysis.

Ranges replaced with averages

- 5-8 → 11.5
- 5-6 → 5.5
- 90-150 → 120

River alkalinities (ES) replaced:

- 4.5.0 → 4.5
- 3.5.0 → 3.5
- 6.1.0 → 6.1
- 0.5.0 → 0.5

Obvious unit errors

- Lake total phosphorus mg/l (ES, CY) instead of µg/l multiplied by 1000
- Chlorophyll and total phosphorus for Grosser Müggelsee (DE) mg/l instead of µg/l multiplied by 1000
- Amount of precipitation mm instead of m divided by 1000

Other errors and inconsistencies:

Sum of CORINE level 1 landcover units < 98%

- Rivers (EE, DE, ES)
- Lakes (DE, SE)
- Coastal waters (GB, NL, EE, SE)

Sum of CORINE level 1 landcover units > 102%

- Rivers (SE)
- Lakes (NL, RO)
- Coastal (GB)

There has also been a general problem concerning the transfer of data on sampling frequencies from the old questionnaire to the new one. According to the request of some experts, the scale for sampling frequency was changed in the new version of the questionnaire. As the two scales were not exactly translatable among each other, the codes entered before changed their meaning (Table 3.1.1).

Some people entering the data corrected the values according to the new scale but some did not notice that the values had become wrong. For most of the sites it is possible to find out whether the numbers are right or wrong:

1) for all sites entered only through the new data entry system are RIGHT
2) for sites entered before, the result is WRONG if the code numbers for sampling frequency have remained unchanged.

Table 3.1.1. *Coding of sampling frequencies in the two versions of metadata questionnaires*

Code	Meaning in the first questionnaire	Meaning in the second questionnaire
1	Continuously	Daily
2	Once a year	Weekly
3	2-6 times a year	Fortnightly
4	7-12 times a year	Monthly
5	>12 times a year	Yearly
6		Irregularly

However, there is a danger that frequencies have been corrected only for some parameters. That means that the codes must be compared for all more than 20 parameters for which sampling frequency data were submitted to be sure they all have been either changed or remained unchanged. These laborious tests have not been carried out yet since it is not clear how much the data on sampling frequencies will really be used within GIGs. **At the moment, the data on sampling frequencies were not included into the analysis.**

Despite of the problems listed above, the data collection proceeded generally smoothly given that it was the first experience in the WFD implementation practice for collecting large amounts of data from the Member States through the web-based data submission system and compiling them into a single database. The lessons learned by the JRC and the Member States during this action will help to improve the WFD reporting system in the future.

3.2. Sense checking of geographic coordinates

The incoming geographical data from the intercalibration submission sites was checked through a semiautomatic procedure, following the three levels of quality control: completeness, consistency and meaningfulness (Fig. 3.2.1).

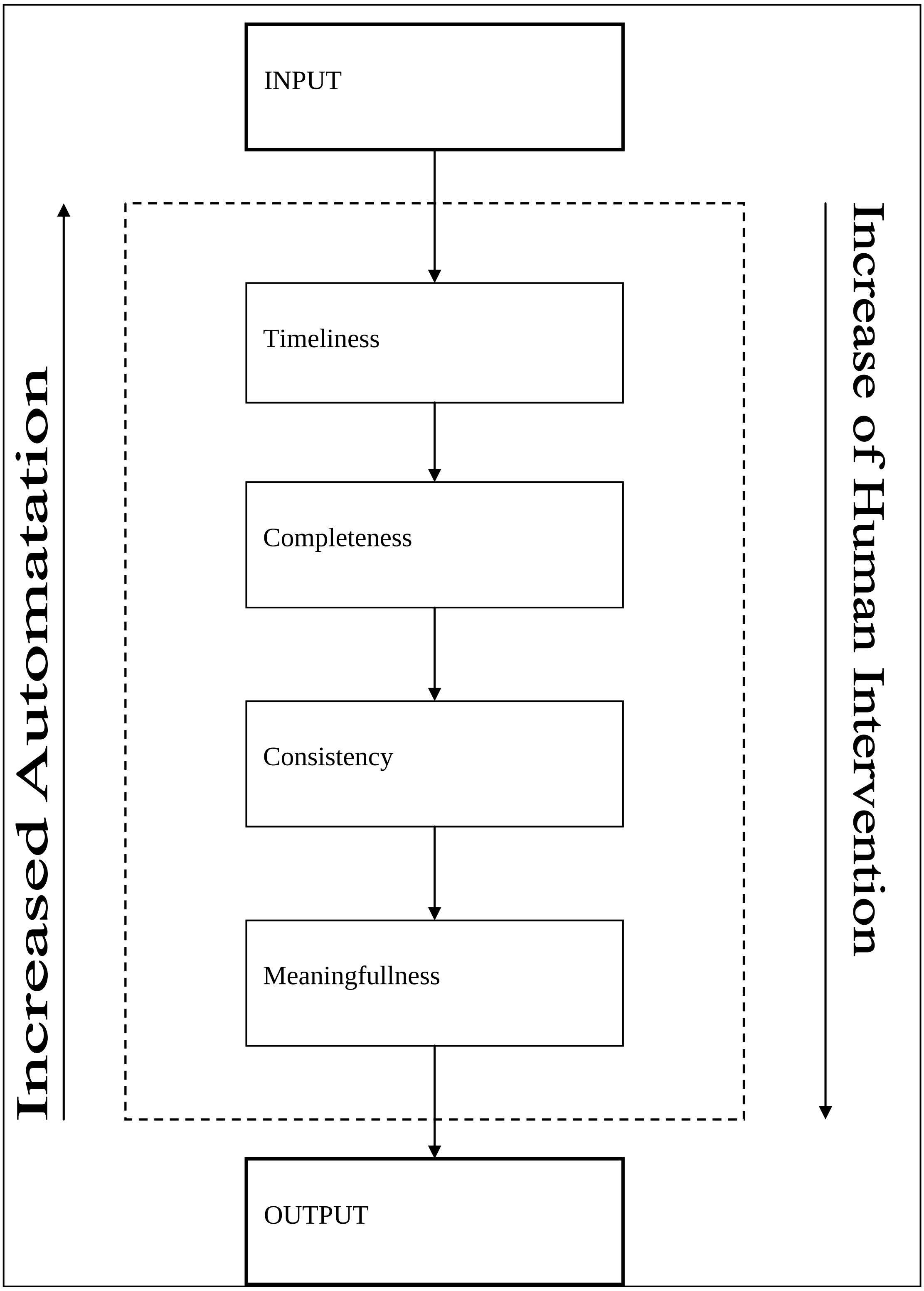


Fig. 3.2.1. Quality control levels on the intercalibration data

At the second level of control, the sites where checked for consistency, exposing, for instance, cases where the latitude and longitude were inverted. Finally a detail human evaluation was made of the meaningfulness, exposing for instance cases where according to coordinates, a lake was situated in the sea, lake reported from one Member State was located in a neighbouring country and some cases where the sites were placed outside the borders of European Union, for instance in Africa.

Our previous experience with the Draft Intercalibration Register showed that one of the biggest sources of location errors was the mixing up east and west longitudes as they were distinguished only by sign (plus or minus). To avoid the repetition of this error in the new questionnaire, the data providers were asked to indicate whether the longitude indicates west or east and a mapping application was set to consider only the absolute value of the longitude as the signs became redundant.

Two preliminary checkings of the location of the sites submitted by Member States and Candidate Countries to the Intercalibration Register were carried out using the GIS-based mapping system. The first one starting on 13 August 2004 and was finished on 23 August 2004, during this period all sites with wrong coordinates were identified and reported to the responsible for submission. The second sense checking was carried out between 17 and 27 September 2004 and also in this case the sites with problematic location were identified and reported to the responsible for submission. The last sense checking of co-ordinates of sites was carried out on 11 November 2004 before sending the data to the Water Directors and the WFD Article 21 committee.

3.3. Outlier analysis

The intercalibration exercise will be carried out at water body type level to ensure that "like" is compared with "like". Because of that, it was important to check the consistency of type parameters of the sites submitted with the ranges of these parameters agreed for common intercalibration types[8]. In a formal analysis we compared the actual values of type parameters for sites with the agreed typology criteria. As an example, the criteria for Atlantic lake types are given in Table 3.3.1.

[8] *Overview of common intercalibration types and guidelines for the selection of intercalibration sites*. Version 4.0, Feb. 26, 2004. Available at http://forum.europa.eu.int/Members/irc/env/wfd/library

Table 3.3.1. *Typology criteria used to identify intercalibration types for Atlantic lakes*

Type	***Lake characterisation***	***Altitude & geo-morphology***	***Mean depth (m)***	***Geology alkalinity (meq/l)***	***Lake size (km2)***
L-A1	*Lowland, shallow, calcareous, small*	<200	3-15	>1 meq/l	Small <0.5
L-A2	*Lowland, shallow, calcareous, large*	<200	3-15	>1 meq/l	Medium to large >0.5
L-A3	*Lowland, shallow, peat, small*	<200	3-15	Peat	Small <0.5

Four parameters: the altitude, mean depth, alkalinity, and lake area were used to identify Atlantic lake types for intercalibration, while water colour was not considered important. As two of the four parameters used, namely the altitude and mean depth, did also not differ between the three lake types, the typology was based, in fact, only on lake size and alkalinity/geology. The latter was an inhomogeneous parameter as it indicated the numeric alkalinity value for two types and only the substrate type was shown for the third. The example highlights some features characteristic of most of the typology systems:

1. Not all typology parameters were considered important within GIGs to create the regional typologies
2. Even if indicated, the values could be indifferent between types. For this reason they were often not shown
3. Besides numeric values verbal descriptors were used to differentiate types.

Most often the altitude was described in the typology schemes in verbal terms without giving the numeric values. In order to check the correspondence of the numeric altitude values given for sites with the verbal criteria, we considered the following ranges given in Annex II of the Water Framework Directive:

- lowland: <200 m
- mid-altitude: 200-800
- high: >800 m

Table 3.3.2. *Parameters used for typology of surface water bodies in the Final Intercalibration Register and the number of sites for which the typology parameters were available/missing*

Water category	Type parameter	Number of sites with data available	% of the total number of sites	Number of sites with missing data
Rivers (883)	Catchment area	816	92	67
	Altitude	802	91	81
	Bankfull width	786	89	97
	Alkalinity	439	50	444
	Colour	101	11	782
Lakes (385)	Surface area	379	98	6
	Altitude	364	95	21
	Mean depth	381	99	4
	Alkalinity	334	87	51
	Colour	174	45	211
Coastal and transitional waters (232)	Current velocity	181	78	51
	Exposure	214	92	18
	Mixing intensity	217	94	15
	Average salinity	119	51	113
	Residence time	157	68	75
	Ice days per year	155	67	77
	Tidal range	192	83	40
	Mean depth	151	65	81

For many sites some of typology parameters were missing (Table 3.3.2). For lakes and rivers the biggest numbers of values were missing for the alkalinity and water colour, which were considered only regionally important. For coastal and transitional water sites data on mean depth and salinity were most often missing. No type criteria at all were given, for example, for Black Sea. For those sites, which had gaps in typology parameters, the consistency with the type description could not be checked, hence, not all outliers could be revealed in the analysis.

We indicated as outliers all sites for which the type parameters

1) remained outside the agreed ranges, regardless of the extent of the deviation,
2) did not mach the agreed value or description of the type criterion.

4. Results

4.1. Sense checking of geographic coordinates

At the last location check, the dataset consisted of 1500 sites. Thirty-six river sites had still no coordinates (indicated as 0000,00). Sense checking of the data on geographic location revealed several errors and inconsistencies (Table 4.1.1). After correction 1462 sites had a reasonable but not necessarily correct position.

Table 4.1.1. *Examples of types of errors found by sense checking in the geographic co-ordinates of sites submitted to the Intercalibration Register*

Type of error	Country	Sites concerned	Action taken
Identical sites names	SE	L879 and L892	Coordinates of L879 overwritten
Two different sites with identical co-ordinates	DE	C336, C411	Corrected
	RO	C347020040524, C347320040524	Corrected
Obvious typing error	NO	R664	Corrected
Outside country	NO	R374320040606, R369520040602, R374220040606	Corrected
	RO	R346420040521	Corrected
	NL	L935	Corrected
	PL	R374520040607	Corrected
Latitude and longitude interchanged	ES	R100, R184	Corrected
	RO	L577, R1102	Corrected
	GB	L371720040602	Corrected

Different indication of the western longitude still included in the database may create problems: in 161 cases western longitude is indicated with a positive value and in 298 cases with a negative value. The sign is a remnant from the first version of the database. In the new data upload system the location to the east or to the west of the Greenwich meridian was asked separately, thus, only the absolute values of the coordinates should be considered.

Several kinds of errors were found in the location data during the sense checking and communicated to the data providers.

4.2. Outlier analysis

Regarding the agreed ranges of typology parameters[9] the analysis revealed altogether 764 outlying values (Appendix 1). Altogether, outliers were found in the data of 542 sites: 304 rivers, 96 lakes, 119 coastal, and 23 transitional water sites (Table 4.2.1).

Table 4.2.1. *Number of sites with outliers and their percentage in the total number of sites by surface water categories*

Water category	Total sites	Sites with outliers	%
Rivers	883	304	34
Lakes	385	96	25
Coastal	190	119	63
Transitional	42	23	55
Total	1500	542	36

On average, more than 1/3 of all sites submitted to the Intercalibration Register deviated to some extent from the agreed type descriptions. Among those sites 131 deviated by two parameters, 26 sites by three parameters, and in the case of 13 coastal water sites even four parameters were outside of the agreed ranges (Table 4.2.2).

[9] *Overview of common intercalibration types and guidelines for the selection of intercalibration sites.* Version 4.0, Feb. 26, 2004. Available at http://forum.europa.eu.int/Members/irc/env/wfd/library

Table 4.2.2. *Number of sites in the Final Intercalibration Register with a different number of outlying parameters per site*

Number of outliers per site	Rivers	Lakes	Coastal	Transitional
4	0	0	13	0
3	5	1	18	2
2	70	14	38	9
1	229	81	50	12

Among rivers the biggest number of outliers (123) were because of deviations from the agreed catchment size, followed by outliers in altitude (117), bankfull width (93), and alkalinity (49) (Table 4.2.3). Lake data had the best fit with the type criteria: for four type parameters the percentage of outliers remained below 10 and was higher only for water colour by which 27 sites (16% of sites with colour data available) deviated from type description. Among coastal and transitional waters for which type criteria were agreed most recently, the percentage of outliers was the highest reaching 30% or more for water residence time (47 cases), current velocity (58 cases), and exposure (66 cases). For the large mismatch between the actual and agreed type parameters within coastal and transitional waters two main causes can be pointed out:

1) Creating a typology like this is a rather new approach for coastal and transitional waters and for this reason there is a lack of knowledge about the variability of several parameters used to describe the types. Perhaps, the type descriptions were too rigid: many type criteria like mixing intensity, degree of exposure, and water residence time were specified in verbal terms very narrowly without giving a range.
2) High number of type descriptors used for the NE Atlantic types (7) made it probably difficult to find sites that match by all of them. As the NE Atlantic group was the biggest constituting more than 60% of all coastal sites and more than 80% of the transitional sites, it affected strongly the overall consistency.

Table 4.2.3. *Number and percentage of outliers in the Final Intercalibration Register by parameters used for typology of surface water bodies*

Water category	Type parameter	Number of sites with data available	Number of outliers	% of outliers among sites with available data
Rivers	**Catchment area**	816	123	15
	Altitude	802	117	15
	Bankfull width	786	93	12
	Alkalinity	439	49	11
	Colour	101	2	2
Lakes	**Surface area**	379	19	5
	Altitude	364	15	4
	Mean depth	381	30	8
	Alkalinity	334	21	6
	Colour	174	27	16
Coastal and transitional waters	**Current velocity**	181	58	32
	Exposure	214	66	31
	Mixing intensity	217	43	20
	Average salinity	119	11	9
	Residence time	157	47	30
	Ice days per year	155	5	3
	Tidal range	192	25	13
	Mean depth	151	13	9

Even more important than the number of parameters by which the sites deviate from the type description is **the extent of the deviation**. In a large number of cases it was obvious that the experts submitting the sites and data had considered the minor deviation of one or even two parameters from the agreed range irrelevant. For numeric type descriptors the extent of deviation is given is Appendix 1. In order to make the extent of deviation comparable for values exceeding the upper agreed limit and remaining below the lower limit, it was calculated as the ratio of the actual to the agreed value or *vice versa* to achieve the result >1 for deviating values.

Table 4.2.4. *Extent of deviation of the type parameters from the agreed type criteria*

Extent of deviation for numeric and non-numeric type parameters	Number of sites
>10-fold	7
5-10-fold	10
2-5-fold	100
1-2-fold	430
1-1.1-fold	72
By 3 classes	1
By 2 classes	7
By 1 class	207

There were only very few cases in which the actual values of type parameters deviated from the type criteria more than 10 times or by three classes of a non-numeric scale (Table 4.2.4). In the majority of cases there was only an up to 2-fold difference or the non-numeric scales differed by one class. In 72 cases the difference in numeric values was in a range between 1.0 and 1.1 that actually can be considered as being on the type boundary. The cases indicated as largely deviating from the types should be checked for possible errors by the data providers. The use of sites, which by some type parameters deviate more than two-fold from the agreed boundaries, for the Intercalibration Exercise is anyway problematic and should be decided in a case-by case manner.

4.3. Sufficient number of sites

In order to apply any statistical techniques for harmonising class boundaries, a minimum number of **five sites per quality class boundary** per type was agreed[10]. This number was used as a landmark in the analysis that focused only on the number

[10]*Towards a Guidance on Establishment of the Intercalibration Network and the Process on the Intercalibration Exercise*. CIS Guidance Document No 6. Produced by Working Group 2.5 – Intercalibration. European Communities, 2003. Available at: http://forum.europa.eu.int/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/

of sites submitted and ignored all other factors that might have affected their comparability within types and, perhaps, lead to exclusion of some of the sites. As agreed by WG2A and explained in "Type manual"[11], each intercalibration type should include sites **from at least two countries**. This was the second numerical criterion, the "sharing criterion", checked in the analysis.

To do the checking, the Excel worksheet containing the list of sites was sorted by type and quality class and the number of sites in each subdivision was counted using the *subtotal* and *count* function. A simple checklist (Tables 4.3.1-4.3.3) was created that included all types split by two quality class boundaries, high/good (H/G) and good/moderate (G/M).

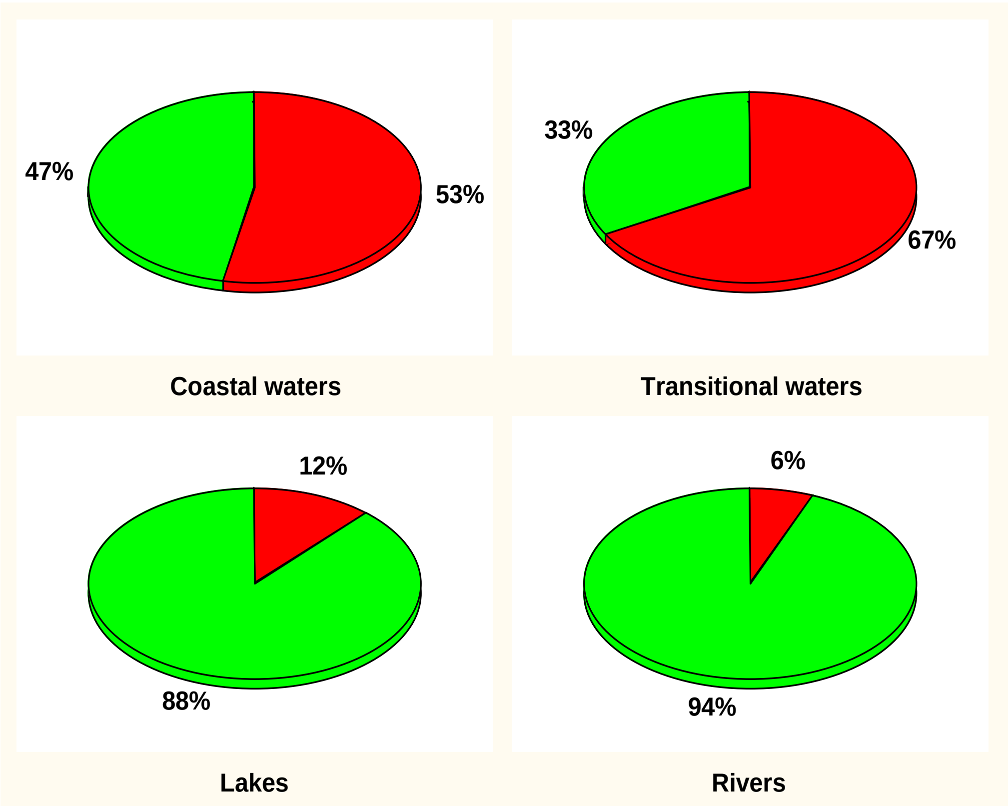


Fig. 4.3.1. Sufficient number of sites per type and quality class boundary by water categories

[11] *Overview of common intercalibration types and guidelines for the selection of intercalibration sites.* Version 2.0, May 19, 2003. Available at http://forum.europa.eu.int/Members/irc/env/wfd/library

Table 4.3.1. *Number of river sites per type and quality class boundary included in the Final Intercalibration Register and the number of countries sharing the sites. Rows with insufficient number of sites and/or countries are highlighted.*

GIG	Type	Quality class boundary	Number of sites	Shared by (number of countries)
RAL	R-A1	GM	18	4
RAL	R-A1	HG	26	5
RAL	R-A2	GM	17	4
RAL	R-A2	HG	23	4
RCE	R-C1	GM	28	11
RCE	R-C1	HG	34	9
RCE	R-C2	GM	19	5
RCE	R-C2	HG	20	4
RCE	R-C3	GM	51	7
RCE	R-C3	HG	69	7
RCE	R-C4	GM	61	12
RCE	R-C4	HG	45	10
RCE	R-C5	GM	23	8
RCE	R-C5	HG	23	8
RCE	R-C6	GM	33	8
RCE	R-C6	HG	40	9
REC	R-E1	GM	4	1
REC	R-E1	HG	9	2
REC	R-E2	GM	12	4
REC	R-E2	HG	5	2
REC	R-E3	GM	6	3
REC	R-E3	HG	3	2
REC	R-E4	GM	7	4
REC	R-E4	HG	6	3
REC	R-E6	GM	9	4
REC	R-E6	HG	2	1
RME	R-M1	GM	12	5
RME	R-M1	HG	18	4
RME	R-M2	GM	21	4
RME	R-M2	HG	23	4
RME	R-M3	GM	15	3
RME	R-M3	HG	32	3
RME	R-M4	GM	10	5
RME	R-M4	HG	14	5
RME	R-M5	GM	8	2
RME	R-M5	HG	17	3
RNO	R-N1	GM	8	3
RNO	R-N1	HG	8	3
RNO	R-N2	GM	12	2
RNO	R-N2	HG	14	3
RNO	R-N3	GM	11	4

RNO	R-N3	HG	12	3
RNO	R-N4	GM	13	2
RNO	R-N4	HG	6	2
RNO	R-N5	GM	10	2
RNO	R-N5	HG	10	3
RNO	R-N9	GM	6	2
RNO	R-N9	HG	10	2

In general, the groups for rivers had the highest level of completeness (94%) and also most of the type/quality boundary groups for lakes (88%) had a sufficient number of sites (Fig. 4.3.1). Among marine sites, especially, in transitional waters several type/quality boundary groups were represented by only one site (Table 4.3.3) and less than one half of the groups fulfilled the agreed numeric criteria. The sharing criterion (at least two countries) was not fulfilled only in cases when also the number of sites was insufficient, i.e., there were no groups, disqualified only based on the sharing criterion.

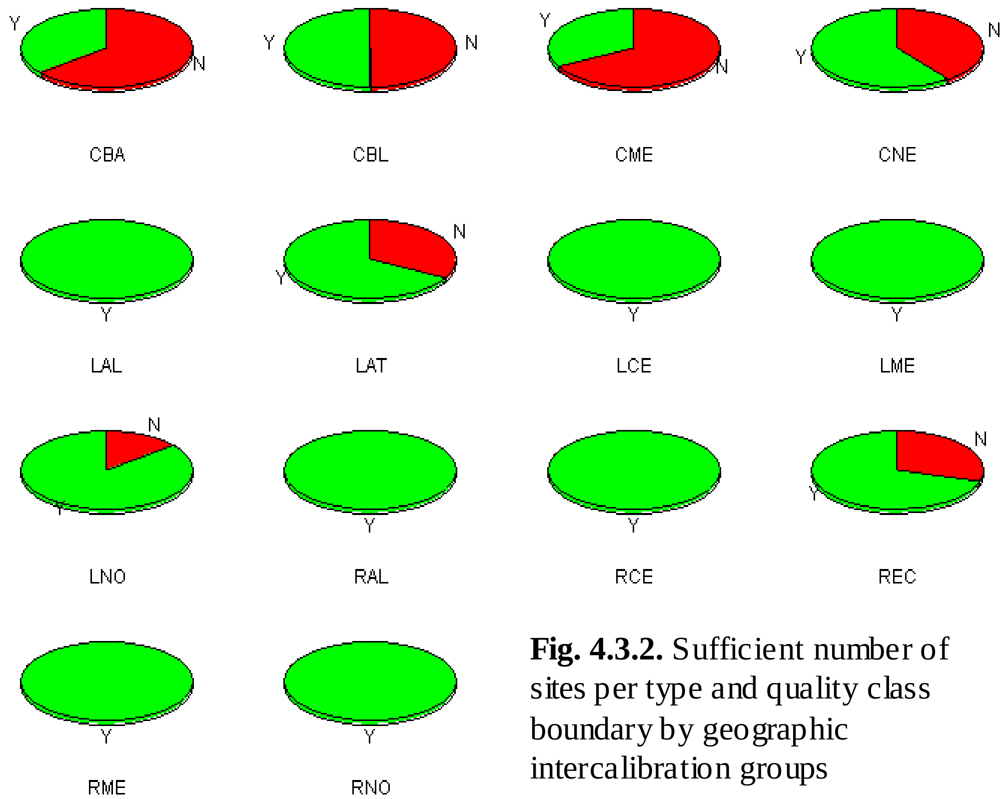


Fig. 4.3.2. Sufficient number of sites per type and quality class boundary by geographic intercalibration groups

Table 4.3.2. *Number of lake sites per type and quality class boundary included in the Final Intercalibration Register and the number of countries sharing the sites. Rows with insufficient numbers of sites and/or countries are highlighted.*

GIG	Type	Quality class boundary	Number of sites	Shared by (number of countries)
LAT	L-A1	GM	8	2
LAT	L-A1	HG	8	2
LAT	L-A2	GM	10	2
LAT	L-A2	HG	7	2
LAT	L-A3	GM	4	2
LAT	L-A3	HG	4	2
LAL	L-AL3	GM	10	5
LAL	L-AL3	HG	18	5
LAL	L-AL4	GM	5	3
LAL	L-AL4	HG	14	3
LCE	L-CE1	GM	19	8
LCE	L-CE1	HG	27	8
LCE	L-CE2	GM	28	9
LCE	L-CE2	HG	22	8
LCE	L-CE3	GM	13	5
LCE	L-CE3	HG	12	5
LME	L-M5	GM	12	3
LME	L-M7	GM	14	4
LME	L-M7	HG	7	2
LME	L-M8	GM	14	5
LNO	L-N1	GM	9	3
LNO	L-N1	HG	8	3
LNO	L-N2a	GM	8	2
LNO	L-N2a	HG	10	3
LNO	L-N2b	GM	2	1
LNO	L-N2b	HG	11	2
LNO	L-N3	GM	16	3
LNO	L-N3	HG	9	3
LNO	L-N5	GM	11	3
LNO	L-N5	HG	16	3
LNO	L-N6	GM	7	2
LNO	L-N6	HG	10	2
LNO	L-N8	GM	10	2
LNO	L-N8	HG	2	2

On the GIG level, one half of GIGs had a sufficient number of sites for all their types (Fig. 4.3.2). Some additions would be required to the Northern and Atlantic GIGs for lakes and to the Eastern-Continental GIG for rivers. All marine GIGs were still incomplete.

Table 4.3.3. *Number of marine sites per type and quality class boundary included in the Final Intercalibration Register and the number of countries sharing the sites. Rows with insufficient numbers of sites and/or countries are highlighted.*

GIG	Type	Quality class boundary	Number of sites	Shared by (number of countries)
CBA	CW-B0	GM	1	1
CBA	CW-B0	HG	4	2
CBA	CW-B12	GM	5	4
CBA	CW-B13	GM	5	5
CBA	CW-B13	HG	5	4
CBA	CW-B14	GM	2	2
CBA	CW-B14	HG	1	1
CBA	CW-B2	GM	3	2
CBA	CW-B2	HG	2	1
CBA	CW-B3	GM	6	2
CBA	CW-B3	HG	4	1
CBL	CW-BL1	GM	6	2
CBL	CW-BL2	GM	1	1
CME	CW-M1	GM	2	2
CME	CW-M1	HG	5	4
CME	CW-M2	GM	3	3
CME	CW-M2	HG	5	4
CME	CW-M3	GM	8	5
CME	CW-M3	HG	5	3
CME	CW-M4	GM	1	1
CME	CW-M4	HG	1	1
CNE	CW-NEA1	GM	24	9
CNE	CW-NEA1	HG	19	6
CNE	CW-NEA10	GM	3	2
CNE	CW-NEA10	HG	4	2
CNE	CW-NEA26	GM	22	8
CNE	CW-NEA26	HG	19	8
CNE	CW-NEA34	GM	6	2
CNE	CW-NEA34	HG	1	1
CNE	CW-NEA7	GM	3	2
CNE	CW-NEA7	HG	3	2
CNE	CW-NEA8	GM	11	3
CNE	CW-NEA9	GM	5	2
CNE	CW-NEA9	HG	1	1
CME	TW-M5	GM	1	1
CME	TW-M6	GM	1	1
CME	TW-M7	GM	1	1
CME	TW-M7	HG	1	1
CNE	TW-NEA11	GM	21	7
CNE	TW-NEA11	HG	11	4

4.4. Data availability for biological and supporting chemical physico-chemical quality elements

4.4.1. Biological quality elements

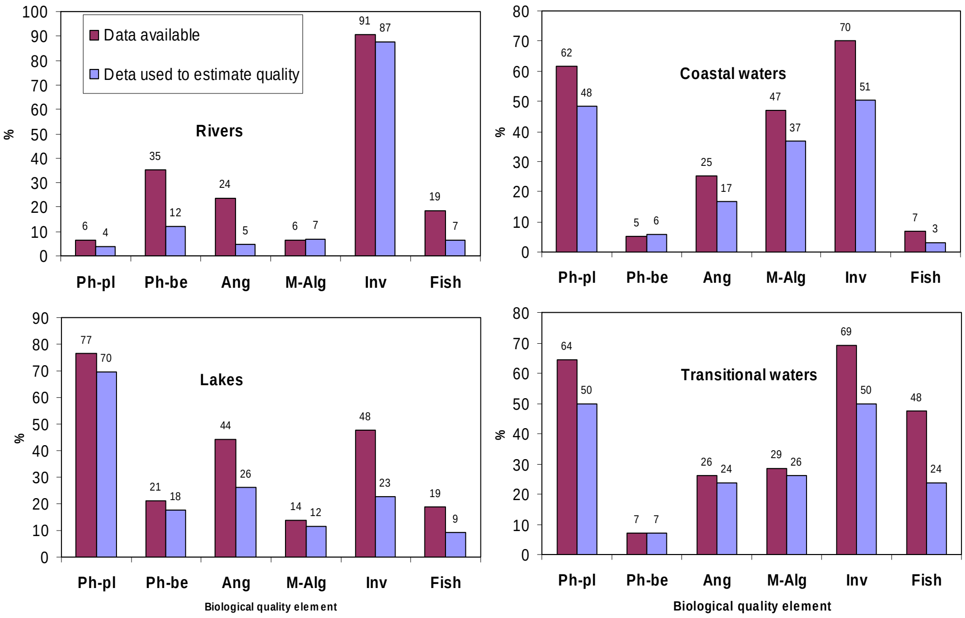


Fig. 4.4.1.1. Per cent availability of biological quality elements for sites submitted to the Final Intercalibration Register and their use for estimating the water quality. Ph-pl – phytoplankton, Ph-be – phytobenthos, Ang – angiosperms, M-Alg – macroalgae, Inv – benthic macroinvertebrates.

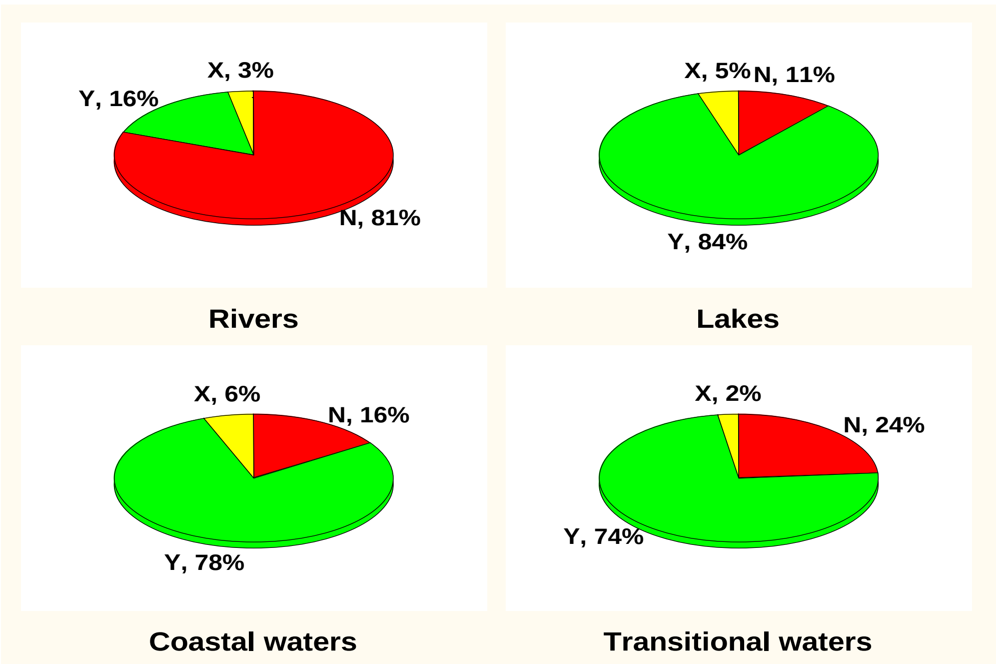


Fig. 4.4.1.2. Availability of chlorophyll data in the Final Intercalibration Register by water categories. Y- yes, N- no, X – no information yet

For lakes the largest amount of data is available on phytoplankton and in rivers on benthic macroinvertebrates. In marine waters both quality elements are nearly equally represented in the database (Fig.4.4.1.1.).

Although **chlorophyll** has not been even mentioned in the WFD, it is a parameter traditionally measured in lakes and marine sites and used as a proxy for phytoplankton biomass. For those water body categories the data on chlorophyll concentration are available for about 80% of sites (Fig. 4.4.1.2.) and it has been often considered as one of the potential indicators to be used as a common metric in intercalibration. In rivers where chlorophyll is less indicative for water quality, this parameter has been measured at only 16% of sites included in the Final Register and the time series are predominantly short (Fig. 4.4.1.3). In lakes and marine areas either one-year data or 2-5-year data were dominating. Among river types chlorophyll has been mostly measured in large (>1000 km^2) lowland rivers within the Eastern Continental GIG, no data are available for the Northern GIG and three Mediterranean river types (App. 2, I). There is a good chlorophyll record available for most types of lakes, coastal and marine waters (App. 2, VII & XIII). Only in lake types L-M7, L-N5 and L-N6 chlorophyll has been measured in less than one half of the sites.

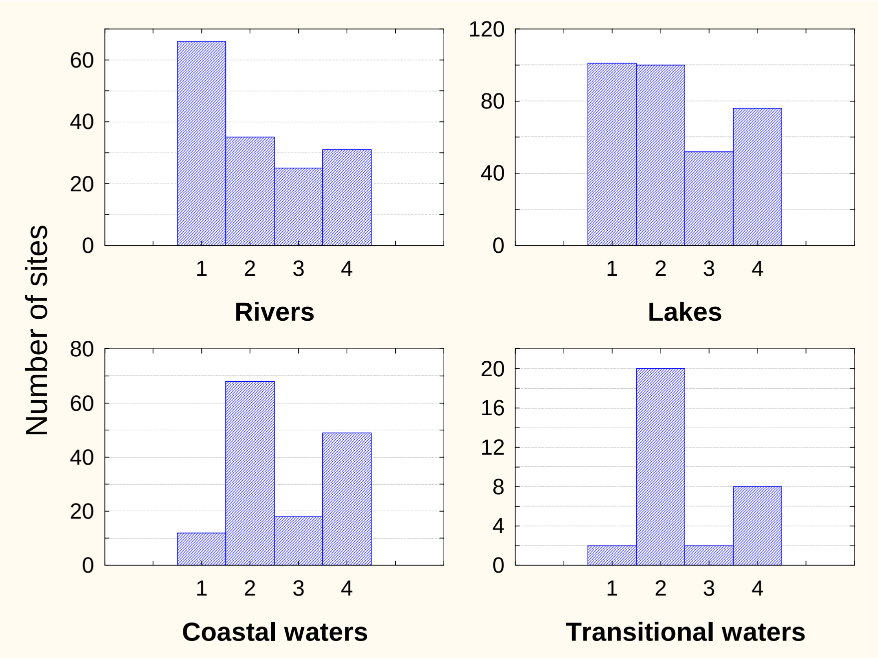


Fig. 4.4.1.3. Length of chlorophyll time series by surface water categories: 1 – 1 year, 2 – 2-5 years, 3 – 5-10 years, 4 - >10 years

Phytoplankton is one of the quality elements stipulated by the WFD for the classification of ecological status of lakes, coastal and transitional waters. The data on phytoplankton showed generally a similar availability as the chlorophyll data, however were a bit scarcer: around 70% for lakes and marine sites and only 6% in rivers (Fig. 4.4.1.4). Among lakes phytoplankton data were available for all sites in two Northern types L-N2a and L-N8, and for less than one half of the sites in L-N6 and L-CE3 (App. 2, VIII). In coastal waters the availability of phytoplankton data differed much between types: for types, CW-BL1 and CW-M4, the availability was 100%, for eleven types it ranged between 50 and 100% and for four types it was less than 50% (App. 2, XIV). Among transitional waters data availability was indicated only for the type TW-NEA11 in which both the chlorophyll and the phytoplankton data were present for 20 of the 32 sites. Among rivers some data on phytoplankton were present within four Eastern Continental types (R-E1, 2, 4 & 6) and within four central types (R-C1, 4, 5 & 6). For 16 river types no phytoplankton data was present. The data series for phytoplankton were mostly short with one-year data dominating for lakes and two-to-five-year data dominating for marine sites. Surprisingly, the data for rivers were mostly rather long exceeding 10 years for 17 river sites (Fig. 4.4.1.5).

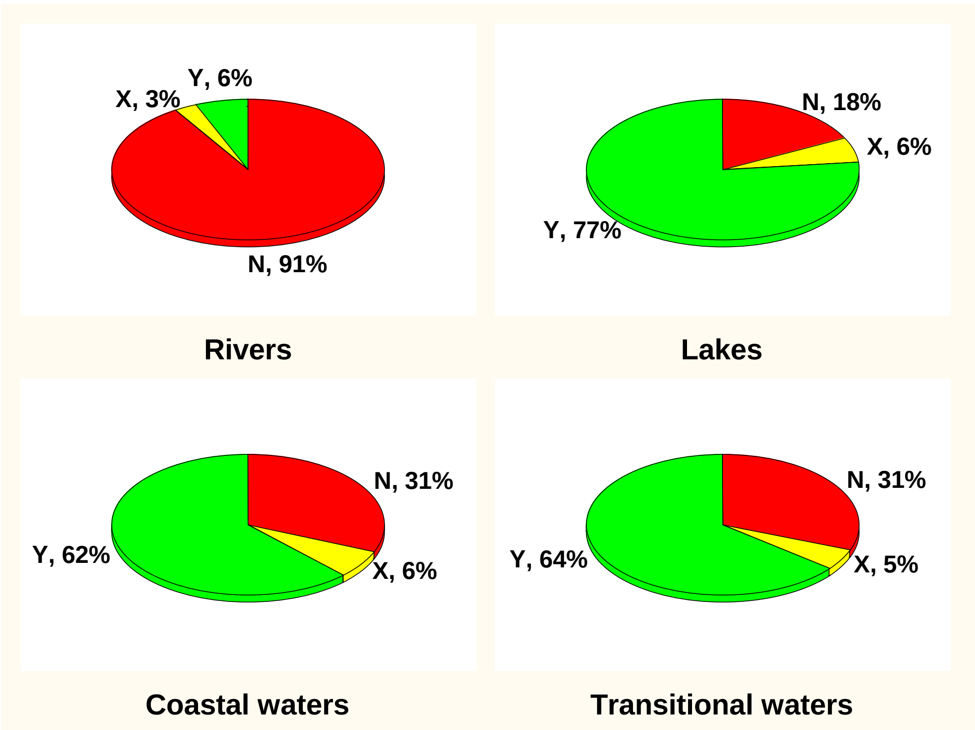


Fig. 4.4.1.4. Availability of phytoplankton data in the Final Intercalibration Register by water categories. Y – yes, N – no, X – no information yet

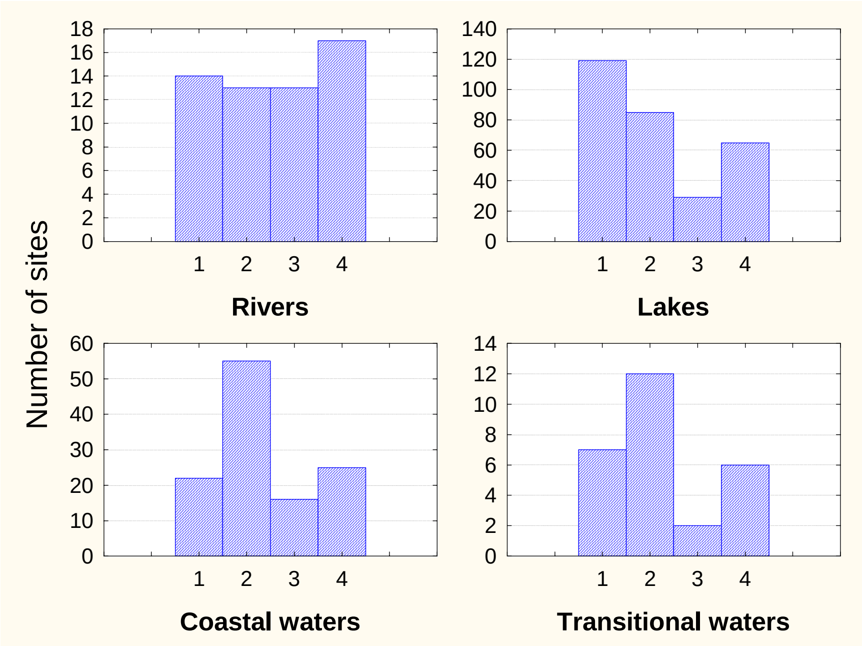


Fig. 4.4.1.5. Length of phytoplankton time series by surface water categories: 1 – 1 year, 2 – 2-5 years, 3 – 5-10 years, 4 - >10 years

Phytobenthos was considered by the WFD one of the important biological elements for water quality assessment in lakes and rivers. Although these water categories were better covered by data on phytobenthos (21 and 35%, respectively) than the marine sites (Fig. 4.4.1.6), the overall availability of data was rather poor. There were no lake or river types in which all sites had data on phytobenthos (App. 2, III and IX). Among rivers the types in which more than 50% of sites had phytobenthos data were R-A1, R-E1&2, R-C2&3, and R-N1&4, and among lakes only L-N2a. There was no phytobenthos data available for R-N9 among rivers and L-A3 and L-N6 among lakes. Despite phytobenthos was not considered as an important quality element for marine sites, data availability for this ecological group was reported from 10 coastal water sites and two transitional water sites. However, the different use of the term phytobenthos in limnology and marine biology should be taken into account: in fresh waters phytobenthos usually means epipelic, epilithic, epipsammic or even epiphytic *microalgae*, in marine literature the term is often used for bottom vegetation as a whole including both the *macroalgae* and *seagrasses.*

The histograms of the length of the time-series (Fig. 4.4.1.7) show a clear domination of the one-year data and even among rivers there are only ten sites with a phytobenthos sampling history longer than 10 years.

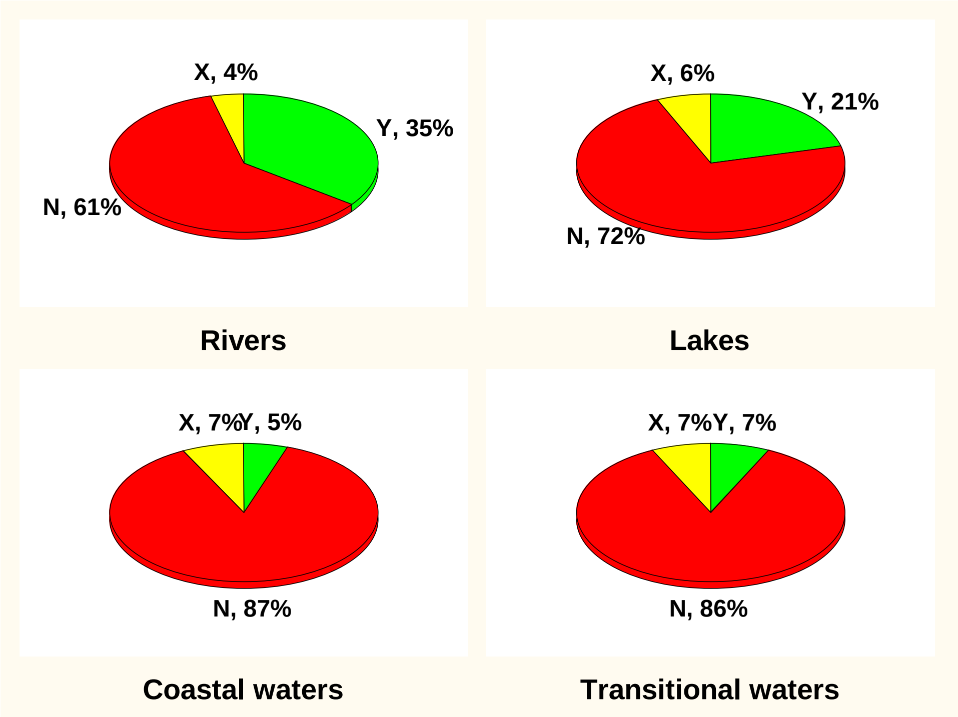


Fig. 4.4.1.6. Availability of phytobenthos data in the final intercalibration register by surface water categories. Y – yes, N – no, X – no information yet

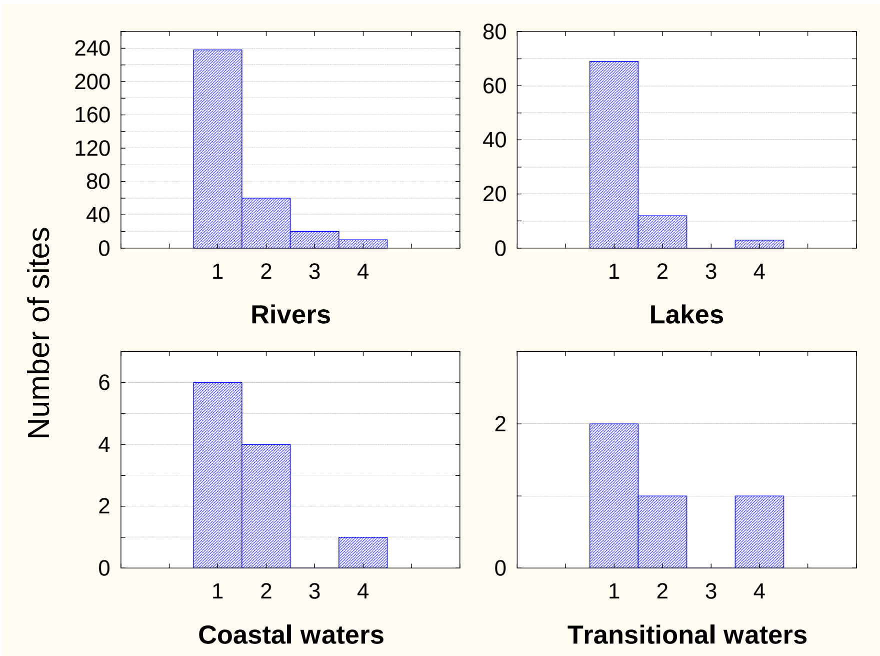


Fig. 4.4.1.7. Length of phytobenthos time series by surface water categories: 1 – 1 year, 2 – 2-5 years, 3 – 5-10 years, 4 - >10 years

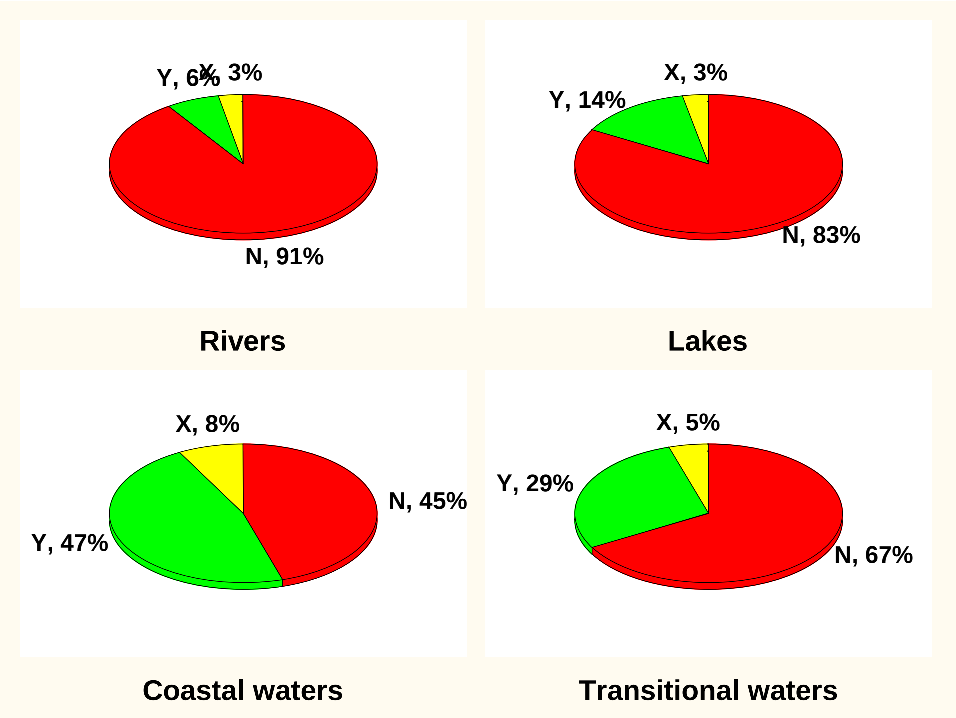


Fig. 4.4.1.8. Availability of data on macroalgae in the final intercalibration register by surface water categories. Y – yes, N – no, X – no information yet

Macroalgae are considered by the WFD as an important water quality indicator for coastal and transitional waters. Data on macroalgae are available for nearly one half of the coastal water sites and from nearly 1/3 of the transitional water sites (Fig. 4.4.1.8). Among coastal sites the data availability for macroalgae is generally good for the Baltic types and for the North-East Atlantic types CW-NEA 8, 9 & 10 and poorer in the Mediterranean and Black Sea types (App. 2, XVI). Some groups of macroalgae like the filamentous green algae (*Spirogyra*, *Oedogonium*, *Cladophora*) and stoneworts are amongst the varieties frequently encountered also in fresh waters. The presence of data on macroalgae was indicated also for 53 mostly Central and Atlantic lakes and 57 Central and Northern rivers.

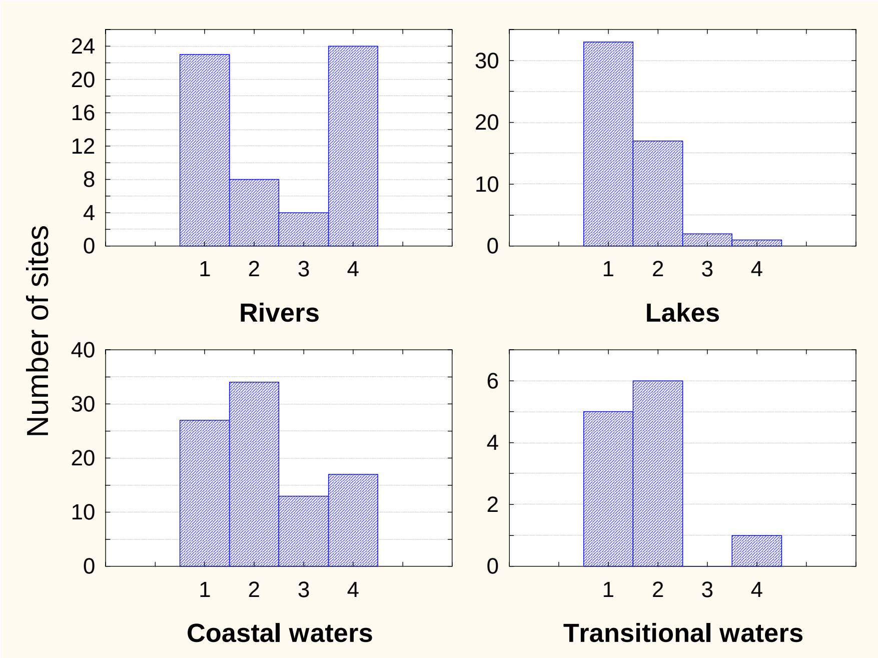


Fig. 4.4.1.9. Length of the time series for macroalgae by surface water categories: 1 – 1 year, 2 – 2-5 years, 3 – 5-10 years, 4 - >10 years

Sampling history for macroalgae has been generally short, in most cases less than five years (Fig. 4.4.1.9). Only for 17 coastal sites and for one transitional water site the time-series exceed the length of 10 years.

Macrophytes are listed by the WFD among important water quality indicators together with phytobenthos for lakes and rivers while **angiosperms** are named together with macroalgae for marine habitats. These two largely overlapping terms have often caused confusion and misunderstanding. Let us define the meaning of these terms here for clarity reasons (Fig. 4.4.1.10): Aquatic macrophytes are aquatic plants that are large enough to be apparent to the naked eye. This term should refer to both angiosperms and macroalgae (note: large algae such as *Nitella* and *Chara* are also included in the category of aquatic macrophytes).

Angiosperms are flowering vascular plants. Unlike gymnosperms such as conifers and cycads, angiosperm's seeds are found in a flower. The term ‘vascular plants’ means that they contain a system of fluid-conducting tubes that differs them from algae. Although macroscopic algae may look like the true, ‘higher’, plants, they are anything else, since they do not have roots or true stems and leaves.

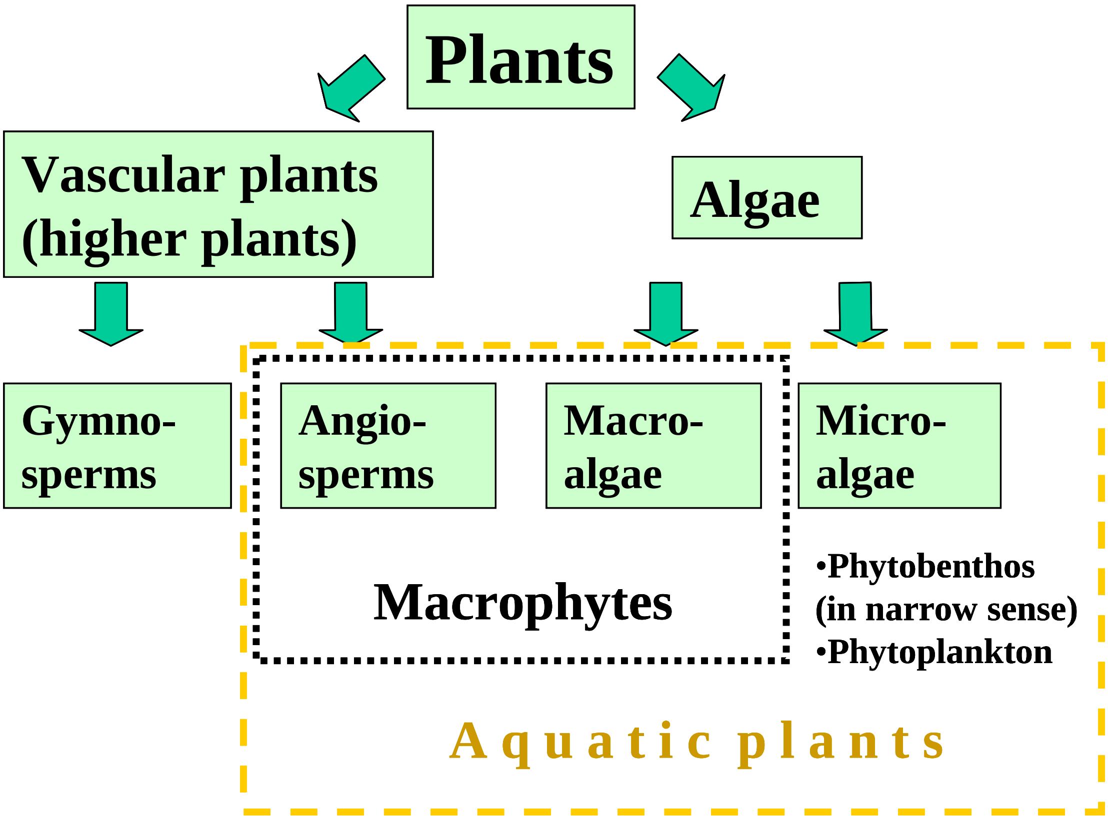


Fig. 4.4.1.10. Explanation of the hierarchy of botanical terms used in the Water Framework Directive

The availability of macrophyte/angiosperm data was very poor. There were data present for only one quarter of rivers, coastal and transitional waters (Fig. 4.4.1.11). Only in two Eastern Continental types (R-E3&6) more than one half of the sites had data for macrophytes (App. 2, IV). Macrophyte data were totally missing from Mediterranean river types R-M2, 3&5 and from all Northern river types. The overall picture for lakes was better: macrophyte data were available for 44% of sites and in 8 types of 18 macrophyte data were present for more than 50% of sites. Similarly to most of the other biological quality elements the sampling history was short with one-year data dominating for lakes and rivers and 2-5-year data for marine habitats (Fig. 4.4.1.12).

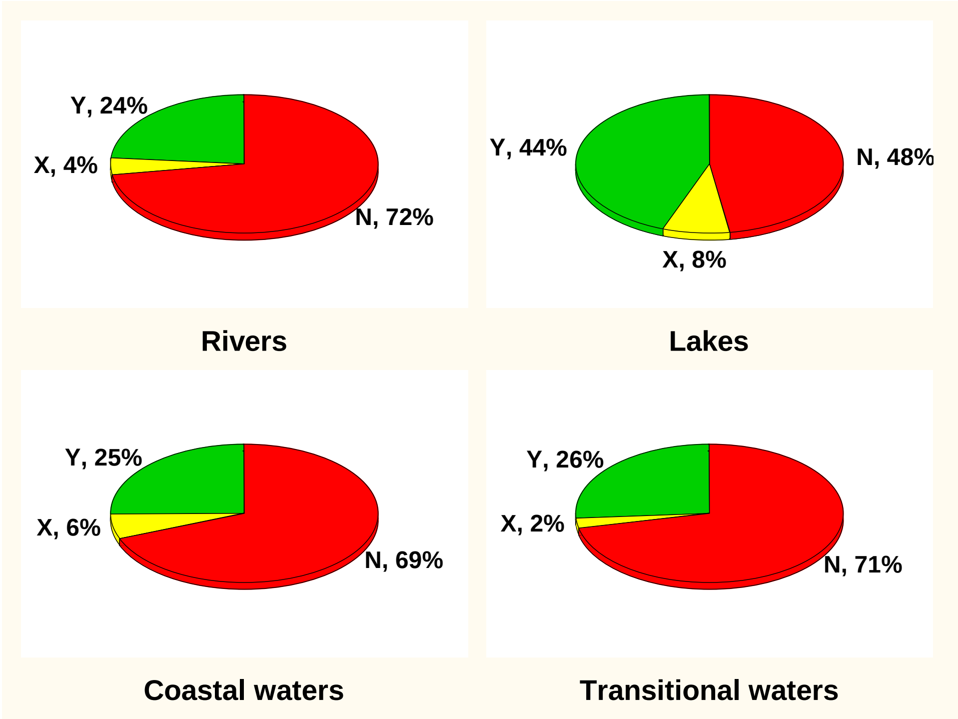


Fig. 4.4.1.11. Availability of data on macrophytes for lakes and rivers and on angiosperms for the marine habitats in the final intercalibration register. Y – yes, N – no, X – no information yet

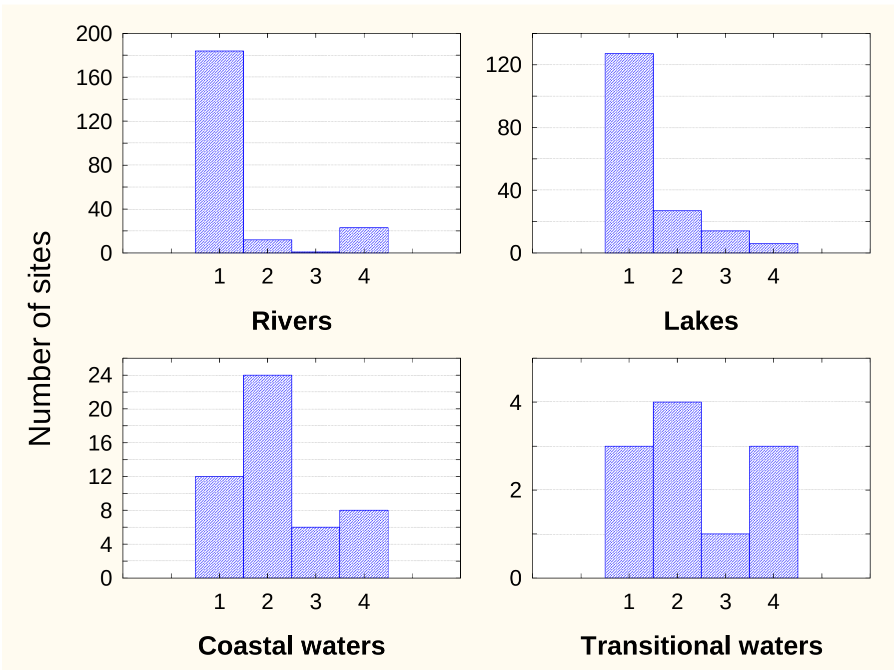


Fig. 4.4.1.12. Length of the time series for macrophyte/angiosperm data by surface water categories: 1 – 1 year, 2 – 2-5 years, 3 – 5-10 years, 4 - >10 years

Benthic macroinvertebrates have been traditionally used for water quality assessment in rivers. Several quality indices like the total macroinvertebrate abundance, total taxa richness, saprobic index, Ephemeroptera, Plecoptera and Trichoptera taxa richness (EPT), Shannon diversity, British Average Score Per Taxon (ASPT), Danish Stream Fauna Index (DSFI), and Swedish acidity index have been widely used and the results compared (e.g. Johnson, 1999, Sandin & Johnson, 2000, Medin *et al*., 2001). The WFD recommends using benthic invertebrates as water quality indicators in all water categories. Besides aquatic flora it is the single quality element which indicative value has been considered universal for all types of surface waters.

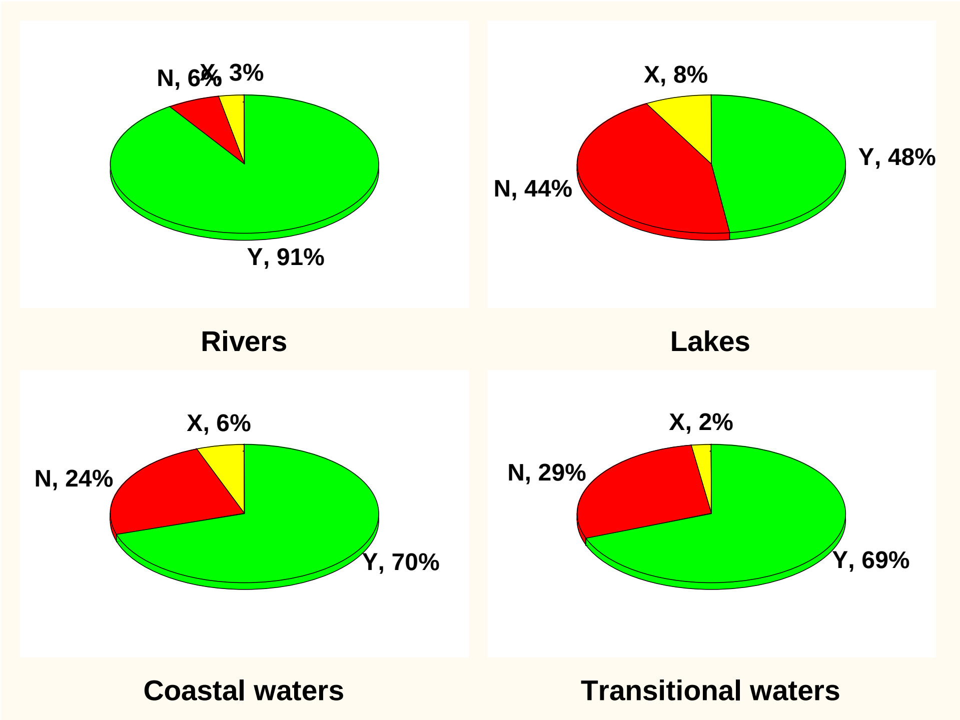


Fig. 4.4.1.13. Availability of data on benthic macroinvertebrates in the final intercalibration register by surface water categories. Y – yes, N – no, X – no information yet

High expectations put on benthic invertebrates can be justified also by rather good overall knowledge and data availability on this biotic group in all water categories (Fig. 4.4.1.13). The river sites in the Final Intercalibration Register were covered by invertebrate data by more than 90%, marine sites by about 70% and only for lakes the data were available for less than one half of the sites. Considering the long tradition of invertebrate-based quality classification and the rather high standardisation level of methods[12], the use of this quality element in rivers is most straightforward. For other water categories the methods have a rather good potential but need further elaboration and specification for different habitats. Data availability on macroinvertebrates was rather homogenous also by water body types within different categories (App. 2. V, XI, XVII).

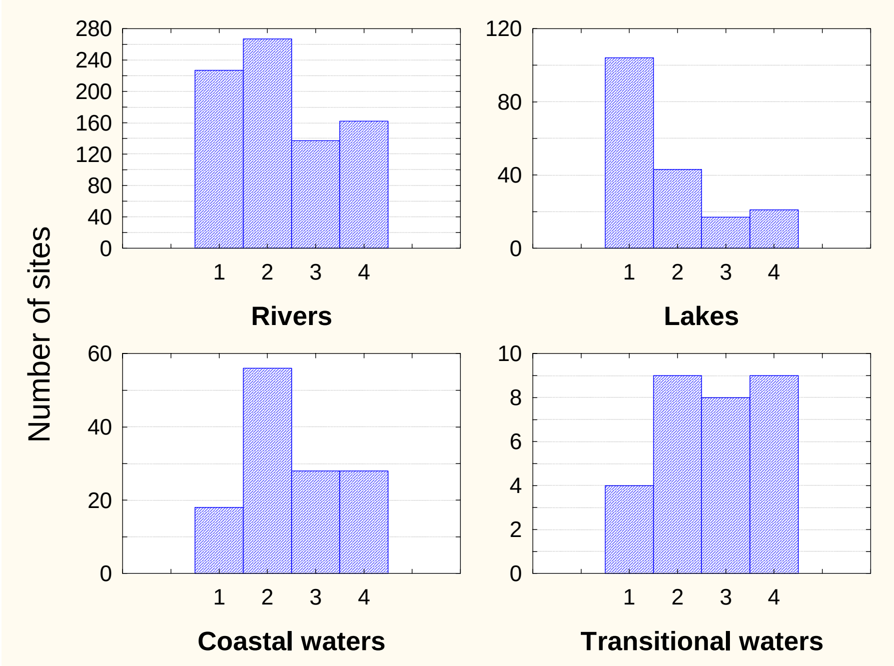


Fig. 4.4.1.14. Length of the time series for benthic macroinvertebrates by surface water categories: 1 – 1 year, 2 – 2-5 years, 3 – 5-10 years, 4 - >10 years

Although rather short time series were dominating for invertebrate data in lakes, rivers and coastal waters, there were still more than 160 rivers, 20 lakes and more than 30 marine sites for which the sampling history was longer than 10 years (Fig. 4.4.1.14).

Fishes were considered by the WFD to have a strong indicative power for water quality in lakes, rivers and transitional waters. However, the data availability is one of the poorest among biological quality elements (Fig. 4.4.1.15). Less than 20% of lakes

[12] European Committee for Standardization, 1994. Water quality – Methods for biological sampling – Guidance on handnet sampling of aquatic benthic macro-invertebrates. EN 27828. European Committee for Standardization, Brussels, Belgium

and rivers and about one half of the transitional water sites have fish data available. Among coastal waters where the use of fish data is not obligatory, the data availability is also the smallest covering only 7% of sites.

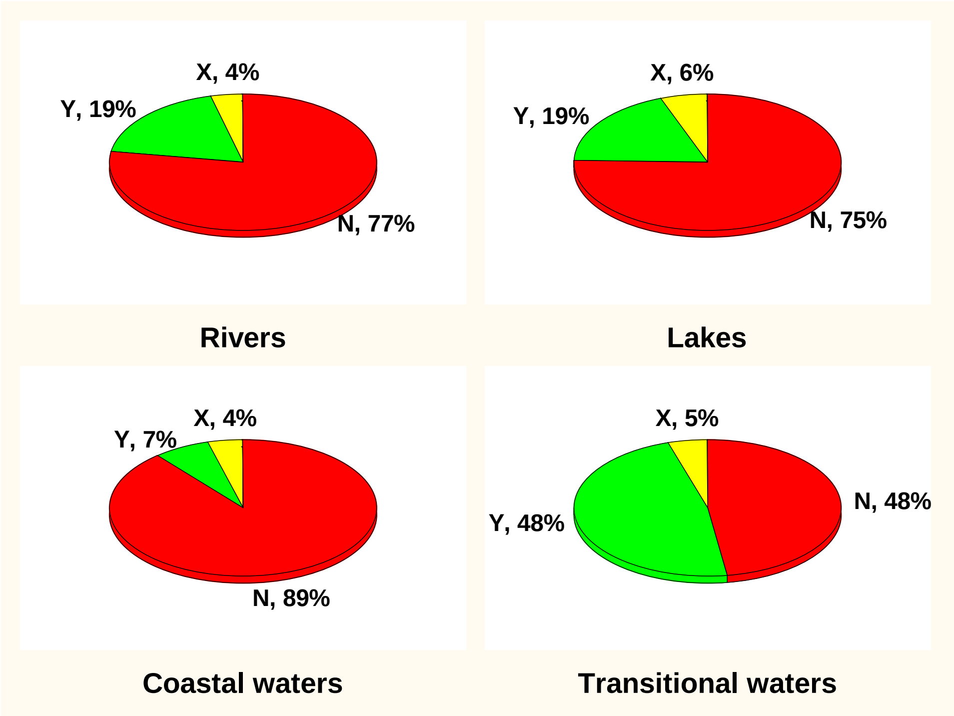


Fig. 4.4.1.15. Availability of fish data in the final intercalibration register by surface water categories. Y – yes, N – no, X – no information yet

4.4.2. Chemical and physico-chemical quality elements

The WFD stipulates some chemical and physico-chemical elements like the thermal conditions, oxygenation conditions, salinity, and nutrient conditions as supporting elements to be used for water quality estimation in all water body categories (Table 4.4.1.1). Additionally, the acidification status is recommended for fresh waters (lakes and rivers), and transparency for standing waters (lakes, coastal and transitional waters). Some of these elements like thermal conditions and salinity are rather conservative and in this sense closer to type parameters while the others reflect sensitively the anthropogenic pressures on water bodies.

There were questions about data availability on 16 chemical and physico-chemical metrics (Table 4.4.1.1) related to the quality elements mentioned above. In the following part we describe the availability of data on those metrics most commonly used.

Table 4.4.1.1. *Chemical and physico-chemical quality elements supporting the biological elements in water quality estimation and the metrics commonly used to describe them.*

Quality element	Rivers	Lakes	Transi-tional waters	Coastal waters	Related metrics
Thermal conditions	+	+	+	+	Water temperature
Oxygen conditions	+	+	+	+	Dissolved oxygen Biochemical oxygen demand Chemical oxygen demand
Salinity	+	+	+	+	Salinity Conductivity
Acidification status	+	+			pH Alkalinity
Nutrient conditions	+	+	+	+	TN, TP NH_4^+, NO_3^-, NO_2^-, PO_4^{3-}
Transparency		+	+	+	Secchi depth Suspended solids Colour

To characterise thermal conditions, water temperature has been measured in the majority of sites (Fig. 4.4.1.16). Thermal regime of water bodies is mostly depending on the geographical location (latitude, altitude), but also on the morphometry and water exchange (standing waters). Thermal regime determines largely the mixing/stratification patterns and the affects the oxygenation regime. Thermal regime can be anthropogenously modified in cases when water bodies receive heated effluent waters or if they are directly used as cooling water reservoirs of power stations.

The oxygenation conditions of water bodies are most directly characterised by the concentration of dissolved oxygen (DO) in water. Data availability on DO was generally good and rather similar to that on temperature. DO has been measured in more than 80% of rivers and transitional waters and in about 70% of lakes and coastal water sites (Fig. 4.4.1.17).

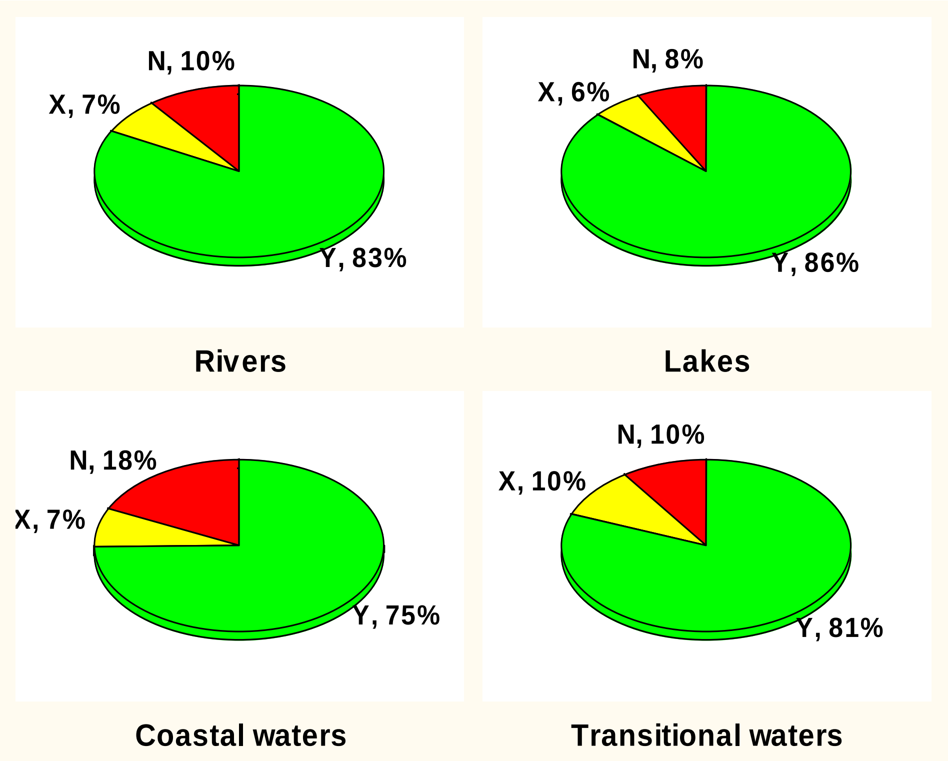


Fig. 4.4.1.16. Availability of water temperature data for the sites included in the Final Intercalibration Register. Y – yes, N – no, X – no information yet

Although salinity conditions are listed by the WFD among quality elements, which should be used in all water categories, it is traditionally measured in marine waters (Fig. 4.4.1.18). Salinity data were available for about 80% of coastal and transitional water sites and missing for a similar proportion of lakes and rivers. Partly this large difference could be explained by different terminology used for marine and fresh waters. In fresh waters dominated mostly by Ca^{++} and Mg^{++} among cations and carbonates or hydrocarbonates among anions, alkalinity reflects rather well the content of these dominating ions. As a proxy for salinity also the conductivity is often measured in fresh waters. Data on conductivity were available for nearly 90% of lakes and rivers and only for 55-65% of marine sites (not shown).

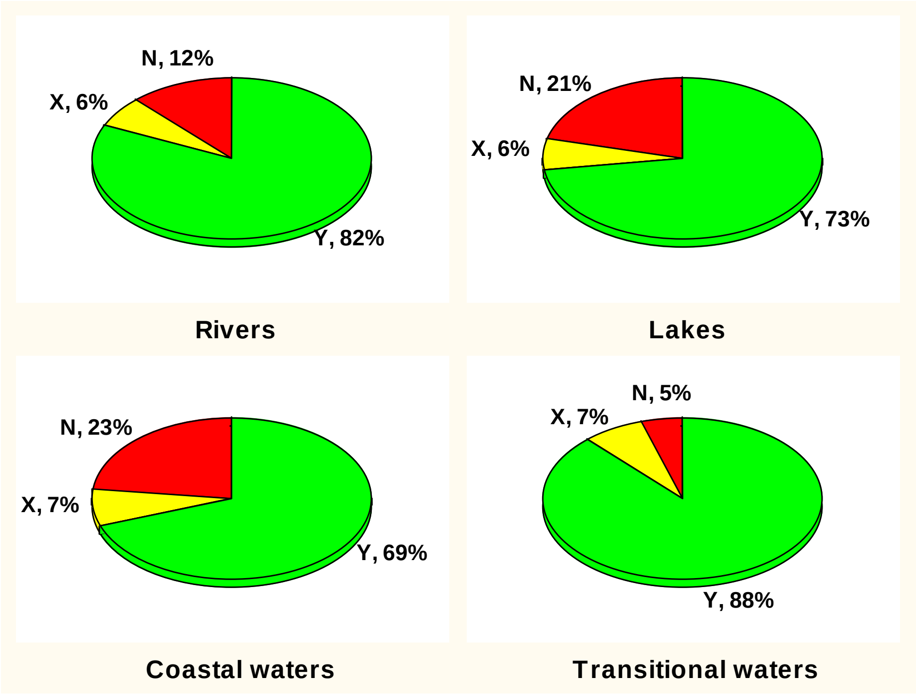


Fig. 4.4.1.17. Availability of data on dissolved oxygen concentration for the sites included in the Final Intercalibration Register. Y – yes, N – no, X – no information yet

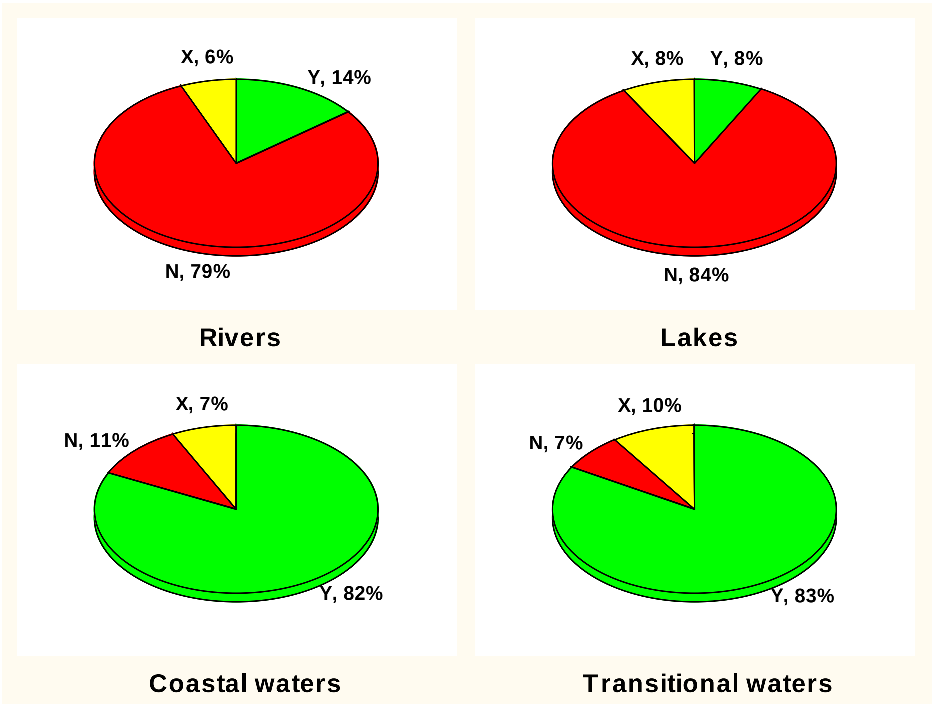


Fig. 4.4.1.18. Availability of data on salinity for the sites included in the Final Intercalibration Register. Y – yes, N – no, X – no information yet

Acidification status of water bodies can be directly measured by pH and indirectly by alkalinity characterising the buffering capacity of water. As a pressure, acidification has an impact only on fresh water systems. The active reaction of water measured as pH belongs to the traditional set of chemical parameters monitored in all types of waters. In the Final Intercalibration Register data on pH were available for about 90% of lakes and rivers, for 3/4 of the transitional water sites and for about 40% of coastal sites (Fig. 4.4.1.19).

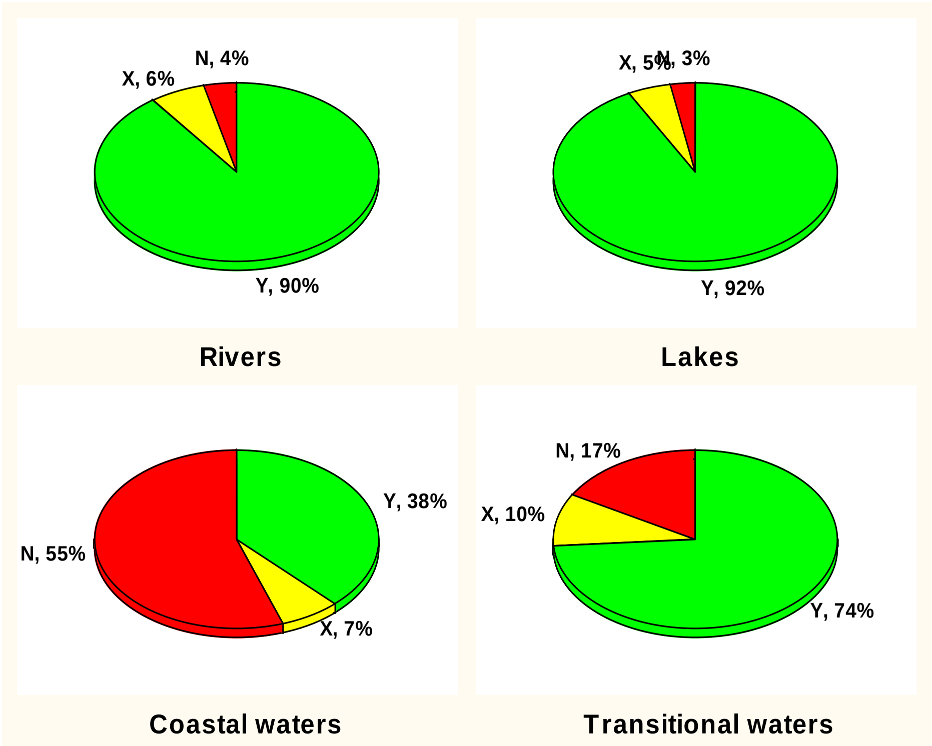


Fig. 4.4.1.19. Availability of data on pH for the sites included in the Final Intercalibration Register. Y – yes, N – no, X – no information yet

Nutrient conditions can be characterised by total nutrient concentrations (TN, TP) or by the availability of the inorganic forms like phosphates, nitrates, and ammonia. As the latter is seasonally highly variable, it is better to use total nutrient concentrations to judge upon the status of water bodies. However, the data availability was better for the inorganic forms of nutrients: data on phosphates and nitrates were available for 76-86% of sites in all water categories (not shown) while data on TN and TP only for

40-65% of rivers and marine sites. Only lakes had a better data coverage reaching up to 68% in terms of TN and 89% in terms of TP (Fig. 4.4.1.20).

Also Secchi depth (Fig. 4.4.1.21) has been measured most often in lakes (73%) followed by coastal waters (51%) and transitional waters (36%). The water flow in rivers and/or the small depth makes it usually impossible to measure the Secchi depth in this water body category.

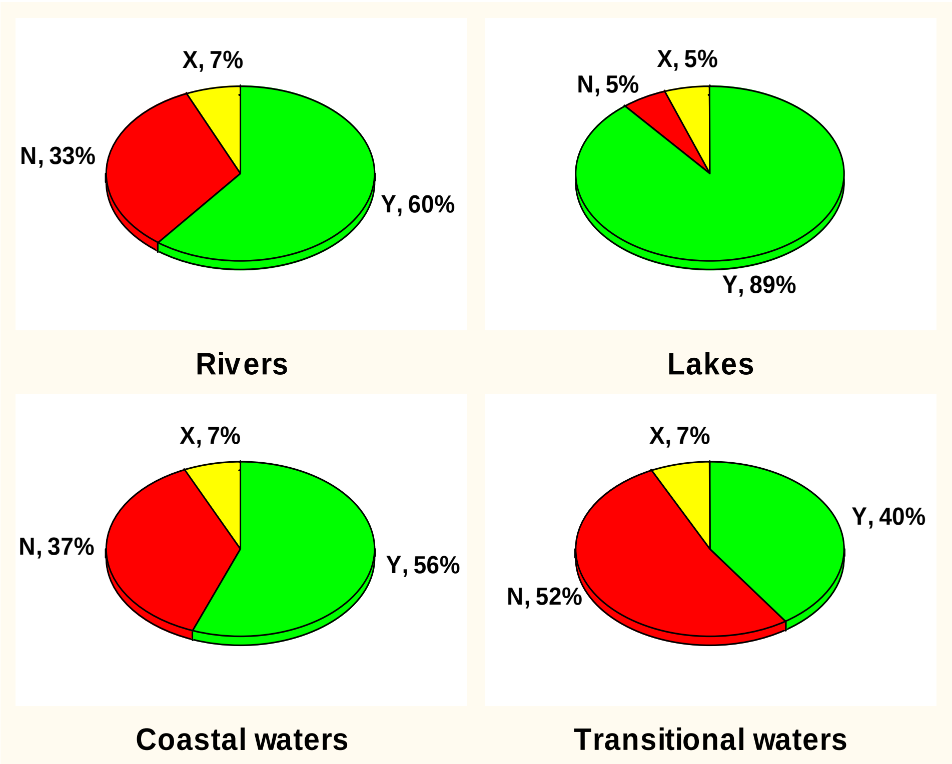


Fig. 4.4.1.20. Availability of data on total phosphorus for the sites included in the Final Intercalibration Register. Y – yes, N – no, X – no information yet

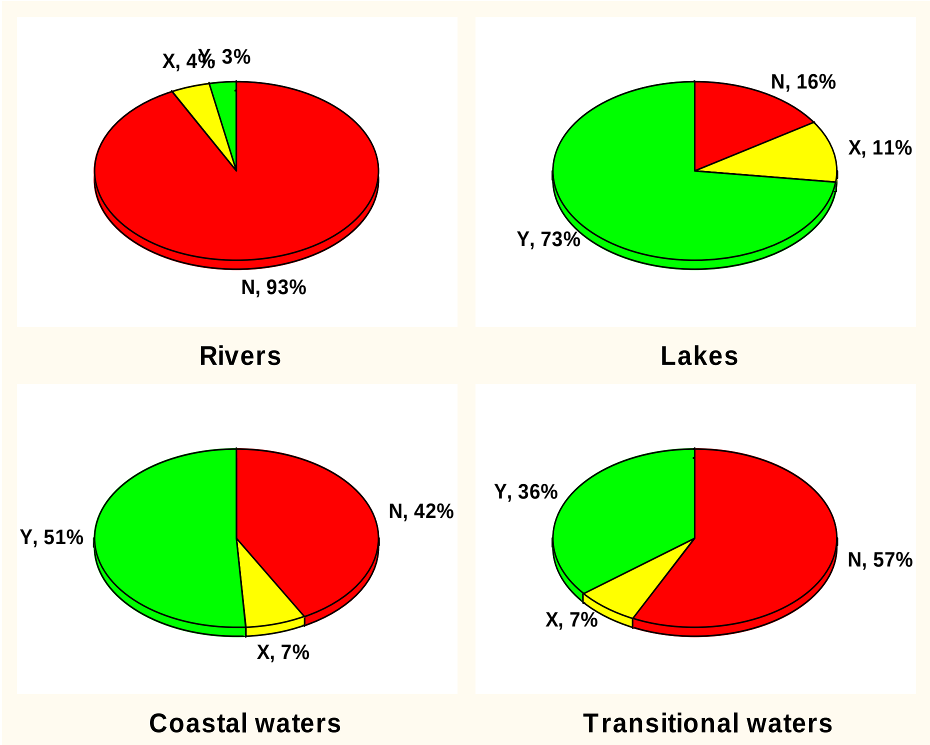


Fig. 4.4.1.21. Availability of data on Secchi depth for the sites included in the Final Intercalibration Register. Y – yes, N – no, X – no information yet

4.5. Factors explaining the variability of sites

The main applications of factor analytic techniques are: (1) to reduce the number of variables and (2) to detect structure in the relationships between variables, that is to classify variables. Therefore, factor analysis is applied as a data reduction or structure detection method. Within water categories a number of parameters characterised the types, geographic location, pressures, and water quality. We applied factor analysis in order to reduce the number of (often strongly correlated) variables and to see what kind of parameters played the major role in structuring the database. The analysis was done only for lakes and rivers, as there were too many gaps in the data for marine sites that reduced the number valid cases to such an extent where it became senseless to carry out the analysis. We used only numeric variables and excluded those for which there were too few valid cases (e.g. rainfall and alkalinity data for rivers, conductivity for lakes, and colour for both lakes and rivers). Finally we could include

109 lakes of the total of 385 (28%) and 595 river sites of the total of 883 (67%) in the analysis. The number of cases for lakes was reduced mostly because of poor availability of on Secchi depth (142 cases), chlorophyll (156 cases), and total phosphorus (165 cases).

In both water body categories the first three factors explained together about one half of the total variability (50.2% in lakes 51.7% in rivers) included in the data (Tables 4.5.1. & 4.5.2). **Factor 1** explaining about 25% of the variability could be considered the **pressure factor** as the pressure parameters like organic and nutrient loading, and landcover contributed most to this factor (Figs. 4.5.1. & 4.5.2.). Also the predefined quality class had one of the highest loadings to this factor for both water categories. Additionally, the alkalinity in lakes and the altitude in rivers had loadings to Factor 1 with absolute values exceeding 0.5.

Table 4.5.1. *Factor loadings of lake variables included in the database for the Final Intercalibration Register. Factor loadings with an absolute value >0.7 are highlighted*

Variable	**Factor 1**	**Factor 2**	**Factor 3**
Latitude (LAT)	0.377	**-0.708**	-0.054
Longitude (LON)	0.161	0.013	**-0.825**
Altitude (ALT)	0.125	0.588	-0.287
Average depth (AvDepth)	0.095	**0.728**	0.017
Lake area (Area)	-0.149	0.451	-0.166
Alkalinity (ALK)	-0.547	0.299	-0.382
Secchi depth (Secchi)	0.494	0.286	0.372
Maximum chlorophyll concentration (MaxChl)	-0.413	-0.431	-0.388
Average total phosphorus (TPav)	-0.388	-0.109	-0.193
Quality class	-0.535	-0.262	0.003
Organic loading (Org. load)	**-0.794**	0.136	0.077
Nutrient loading (Nutr. Load)	**-0.705**	-0.017	0.227
% of agricultural land in catchment (Agric)	**-0.729**	0.061	0.270
% of forest in catchment (Forest)	**0.747**	-0.011	-0.061
Explained total variance, %	**25.6**	**14.6**	**10.0**

__Table 4.5.2.__ Factor loadings of river variables included in the database for the Final Intercalibration Register. Loadings with an absolute value >0.7 are highlighted

Variable	Factor 1	Factor 2	Factor 3
Latitude (LAT)	-0.133	0.243	**-0.790**
Longitude (LON)	-0.051	0.514	-0.279
Catchment area (Catch)	-0.135	**0.786**	0.367
Altitude (ALT)	0.564	-0.066	0.412
Bed width (Bed)	-0.197	**0.770**	0.393
Quality class	-0.522	-0.051	-0.021
Organic loading (Org. load)	**-0.727**	-0.144	0.278
Nutrient loading (Nutr. Load)	**-0.785**	-0.122	0.190
Acidification pressure (Acid)	0.158	-0.142	-0.035
Morphological alterations (MorphAlt)	-0.061	-0.393	0.482
% of agricultural land in catchment (Agric)	-0.691	-0.081	-0.138
% of forest in catchment (Forest)	**0.769**	0.090	0.072
Explained total variance, %	**24.3**	**14.7**	**12.8**

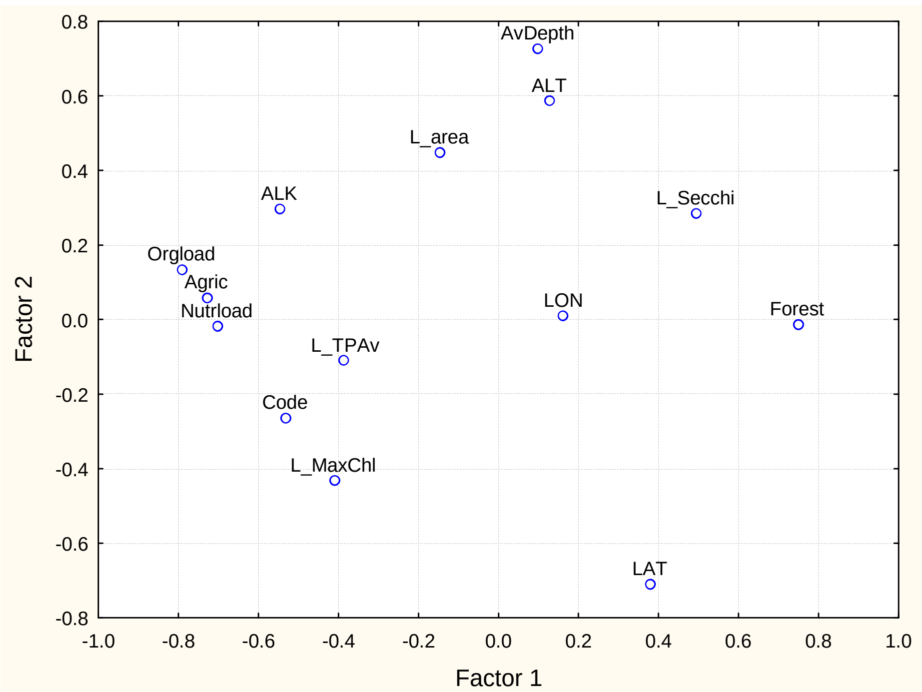


Fig. 4.5.1. Factor loadings of different variables characterising lakes in the Final Intercalibration Register. See Table 4.5.1. for abbreviations of variables

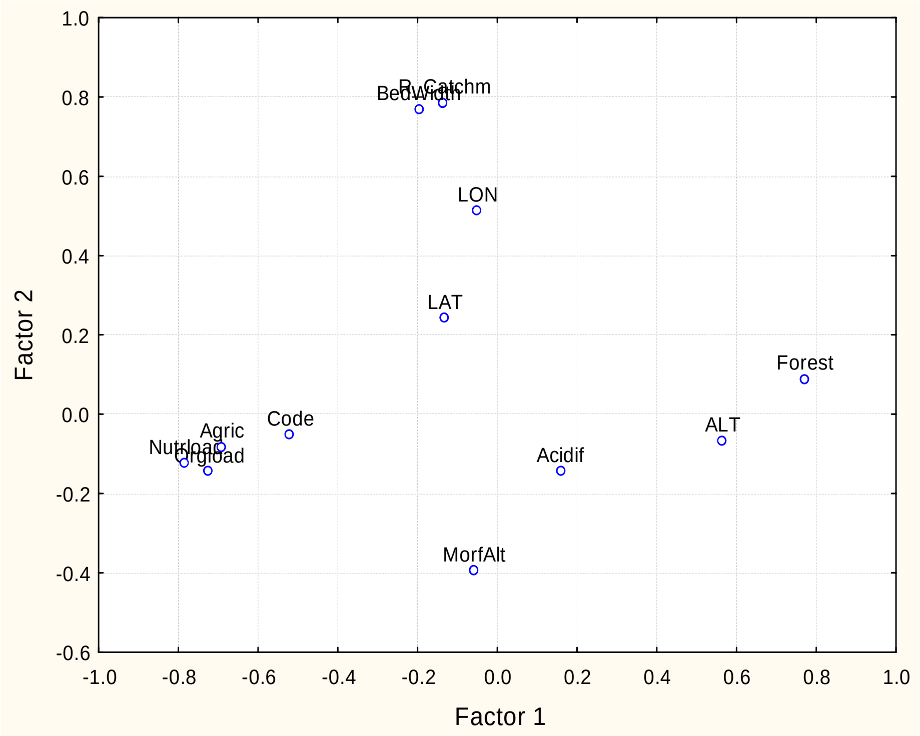


Fig. 4.5.2. Factor loadings of different variables characterising rivers in the Final Intercalibration Register. See Table 4.5.2 for abbreviations of variables

4.6. Differences along the indicated quality class gradient

The sites of the Final Intercalibration Register should represent boundaries between quality classes High-Good (H-G) and Good-Moderate (G/M), based on the WFD normative definitions. The WFD requires that selection of these sites be carried out "using expert judgment based on joint inspections and all available information[13]". However, there is no guarantee that different Member States will have the same views on how the normative definitions should be interpreted and, hence, the intercalibration sites represent their interpretation of the WFD normative definitions of high, good and moderate status. Further more some of the Member States declared that they are not exactly sure that the sites submitted to the Final Register really represent the boundaries, which should be rather narrow compared to the classes, which they separate. In order to enable a better specification of the quality estimate, additional choices were included in the new version of the questionnaire. In addition to the

[13] WFD Annex V, 1.4.1 (v)

required quality class boundary, the Member States were asked if they consider the site really being close to the boundary or rather representing the quality classes. A real advantage of this was that the water quality scale, which had initially only two categories (H/G & G/M), was widened to five categories (H, H/G, G, G/M, M). The more detailed scale enabled to analyze better the pressure-impact relationships and to point out some quality elements, which could potentially be used in intercalibration.

For all water categories the database included 1) typology criteria (different sets by categories), 2) pressure information, and 3) landcover information, which could be analyzed against the quality scale. After analyzing the metadata for sites in the Draft Intercalibration Register, Member State experts decided that more data would be needed to decide upon the comparability of sites indicated as belonging to one type. In the second phase of site submission after launching the new questionnaire in 2004, different sets of additional data were added to different water body categories (Table 4.6.1). For rivers and marine sites the information added contributed mostly to a better type description whereas in the case lakes the new parameters reflected more the water quality aspect.

Table 4.6.1. *Additional data asked for the intercalibration sites submitted to the Final Intercalibration Register*

Rivers	**Lakes**	**Coastal & transitional waters**
Subdominant substrate	Residence time	Surface salinity
Annual rainfall	Maximum chlorophyll	Deep water salinity
Wet trimester (WT)	Secchi depth	Number of ice days
Precipitation during WT	Average total phosphorus	Habitat type
Dry trimester (DT)	Maximum total phosphorus	
Precipitation during DT		
No. of ice cover months		

Analyses of data common for all water body categories were carried out throughout the whole database.

4.6.1. Differences in pressures

The experts submitting metadata for the sites were asked to estimate the strength of different pressures affecting the sites. The following pressure levels were given as options: 0 – absent, 1 – very low, 2 – low, 3 – moderate, 4 – high, and 5 – unknown or non-applicable. Before analyzing the data, the cells containing the fifth option were deleted. The pressures could be divided into three groups:

1) Pollution pressures
    a. Organic loading
    b. Nutrient loading
    c. Acidification
    d. Hazardous substances
2) Disturbance pressures
    a. Fishing
    b. Navigation
    c. Alien species
    d. Heat pollution
3) Morphological alteration pressures
    a. Channelling
    b. Harbour construction
    c. Urbanization
    d. Other shore alterations
    e. Dredging
    f. Damming
    g. Level alterations
    h. Changes in currents
    i. Stratification
    j. Water abstraction

In order to analyze the pressure data, we calculated average pressures by groups for each site (Figs. 4.6.1.2 - 4.6.1.4). All groups of pressures were the strongest for transitional waters followed by coastal waters, lakes, and rivers (Fig. 4.6.1.1). In all cases the differences between lakes and rivers were non-significant. For all water categories the total pollution pressure was the strongest while the pressures caused by disturbance and morphological alterations were at about the same level.

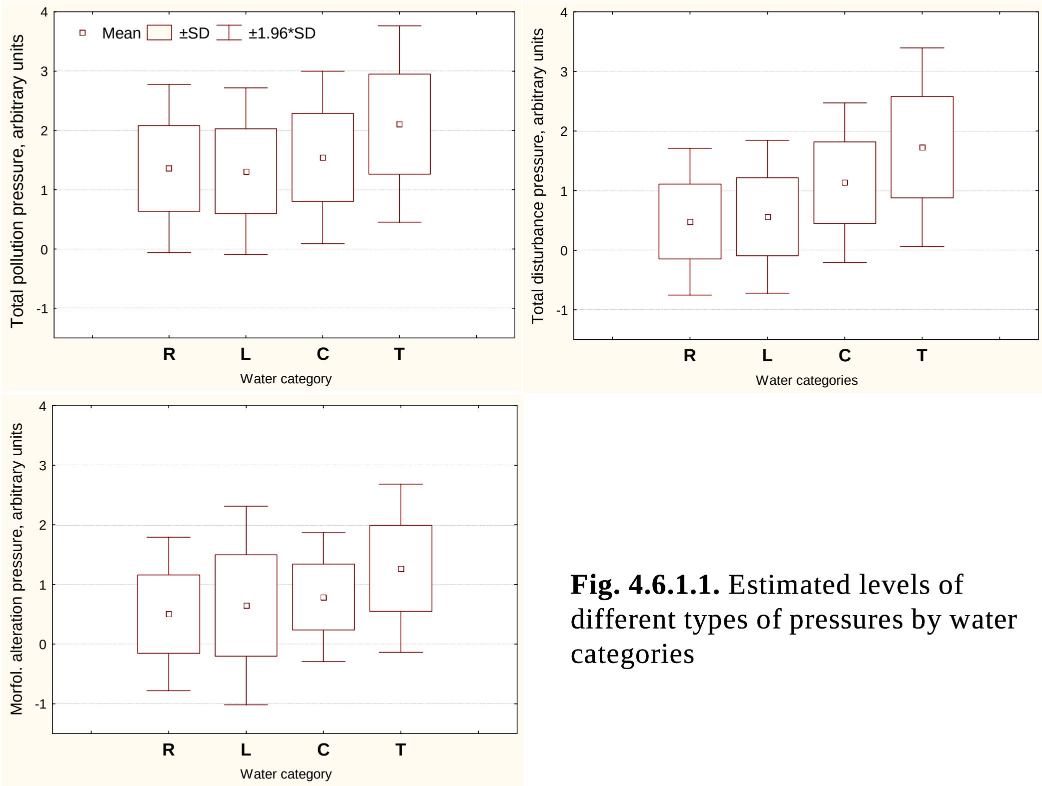


Fig. 4.6.1.1. Estimated levels of different types of pressures by water categories

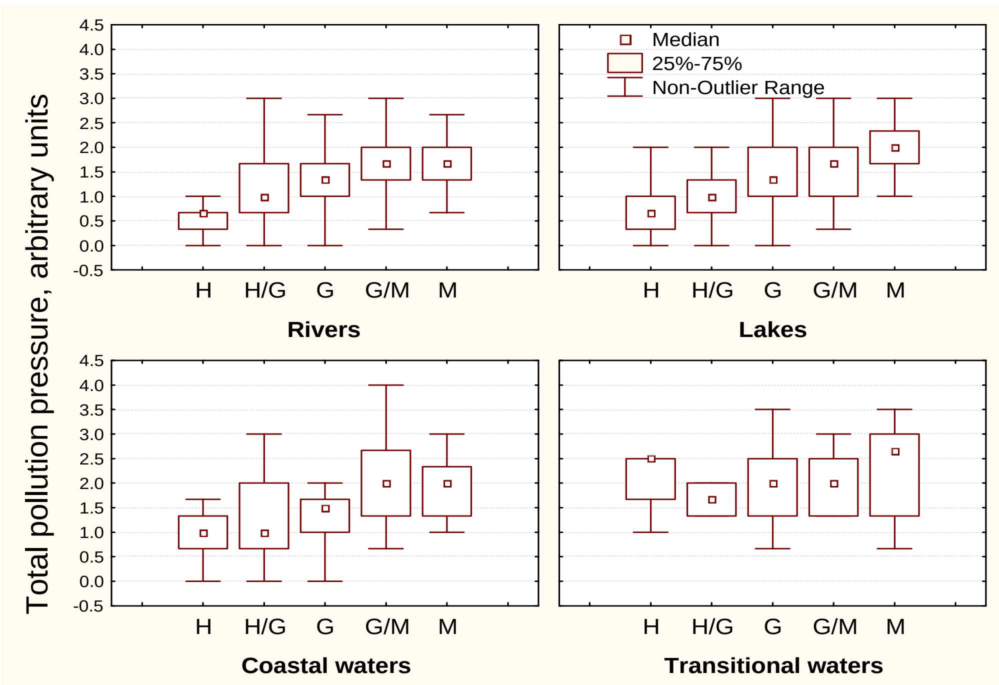


Fig. 4.6.1.2. Changes in the summary pollution pressure (organic matter, nutrients, acidification, hazardous substances) along the water quality axes in the intercalibration register. H – ‘high’, G – ‘good’, M – ‘moderate’

There was a rather linear increase in the median values of the **total pollution pressure** along the quality degradation axis for rivers, lakes and coastal waters (Fig. 4.6.1.2) for which the effect of the quality class was statistically significant (one-way ANOVA, $p<0.05$). In the scale of 0-4 the H/G boundary was mostly located at 1 (very low) and the G/M boundary around 2 (low). Pollution pressure between these two quality class boundaries differed significantly among rivers, lakes, and coastal waters (Table 4.6.1.2). The result could be expected as both, the estimate of the quality class as well as of the pressure level, were subjective and were (perhaps) defined based on the normative definitions given in the WFD. For all these three water categories (R, L & C) the pollution pressure varied in a wide range within quality classes and not all steps on the quality scale differed significantly. Probably because of the small number of sites, no one of the pressure groups had a significant relationship with the estimated water quality among transitional waters. There was a seeming nonlinearity in the loading-quality relationship for transitional waters in which the median loading pressure at high quality sites exceeded even that of the G/M boundary, however all the differences between quality class groups were non-significant.

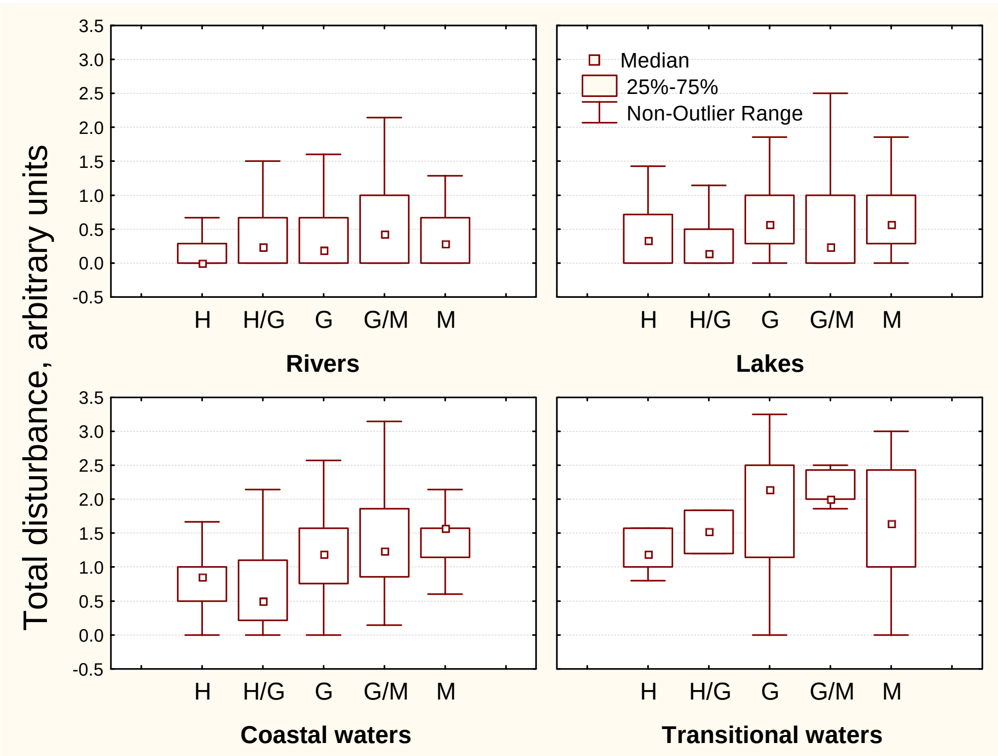


Fig. 4.6.1.3. Changes in the summary distubance pressure (fishing, navigation, alien species, heat pollution) along the water quality axes in the intercalibration register. H – ‘high’, G – ‘good’, M – ‘moderate’

The disturbance pressures were generally rather marginal remaining below 1 (weak) for 75% of lakes and rivers even in the moderate quality class (Fig. 4.6.1.3). For coastal waters the scale was wider and for transitional waters even 75% of the high quality sites were slightly impacted by disturbance pressures. Similarly to the pollution pressure also the total disturbance pressure was significantly related with the quality estimate for lakes, rivers and coastal waters whereas for transitional waters the relationship remained statistically insignificant. The average disturbance pressure was significantly higher for the G/M class boundary compared to the H/G boundary among rivers and coastal waters (Table 4.6.1.2); among lakes and transitional waters the boundaries did not differ significantly.

Table 4.6.1.2. *Significant ($p<0.05$) differences in average pressures found between the groups of surface water sites supposed to represent the high/good and good/moderate quality class boundaries*

Type of pressure	**Rivers**	**Lakes**	**Coastal waters**	**Transitional waters**
Pollution	+	+	+	-
Disturbance	+	-	+	-
Morphological alterations	+	+	+	-

The group of morphological alteration pressures integrated a large number of possible alterations. It was significantly related with the quality class and also the two quality class boundaries (H/G & G/M) differed significantly for lakes, rivers, and coastal waters (Table 4.6.1.2). For these water categories the average morphological alteration pressure was weak or less than weak for 75% of sites (Fig. 4.6.1.4). For transitional water sites the morphological alteration pressures were generally higher and their level was not related with the quality estimate.

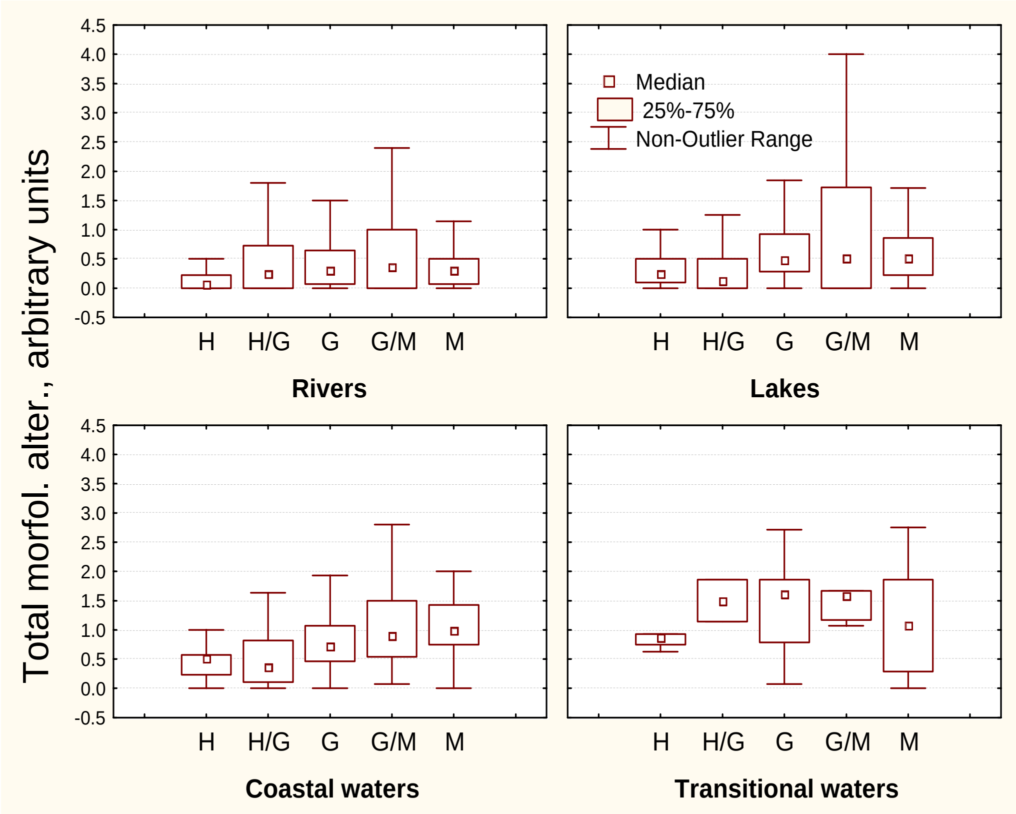


Fig. 4.6.1.4. Changes in the summary morphological alteration pressure along the water quality axes in the intercalibration register. Pressures included: channeling, harbour construction, urbanisation, other shore alterations, dredging, damming, level alterations, changes in currents and stratification, water abstraction. H – 'high', G – 'good', M – 'moderate'

4.6.2. Differences in the catchment land cover

In the questionnaire experts were asked to describe the land cover in the catchment as the per cent distribution between the five basic (level 1) land cover classes of CORINE: agricultural areas, forests and semi-natural areas, wetlands, water bodies and artificial surfaces.

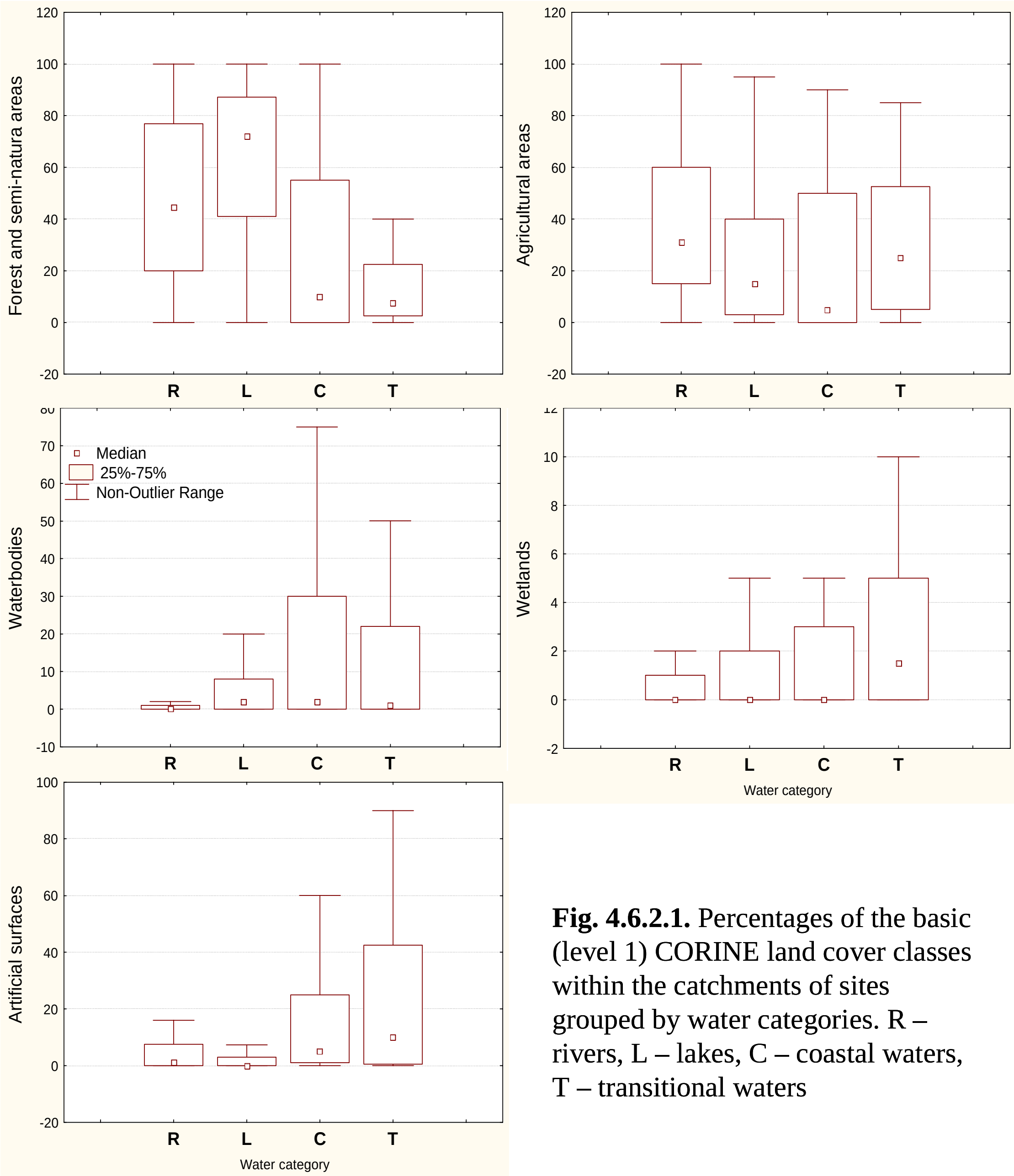


Fig. 4.6.2.1. Percentages of the basic (level 1) CORINE land cover classes within the catchments of sites grouped by water categories. R – rivers, L – lakes, C – coastal waters, T – transitional waters

There was the biggest percentage of forests and semi-natural areas in the catchments of lakes (Fig. 4.6.2.1) with a median value of 72% followed by rivers (44%), coastal waters (10%) and transitional waters (8%). The distribution of agricultural areas was most even between water categories varying from 5% for coastal waters to 31% for rivers. Transitional waters could be distinguished by high relative proportions of both artificial surfaces (10%) and wetlands (1.5%).

We found several significant relationships between the percentages of various land cover classes and the estimated water quality in rivers, lakes, and coastal waters (Table 4.6.2.1). The percentage of artificial surfaces and agricultural areas increased together with degrading water quality (Figs. 4.6.2.2 – 4.6.2.4) while that of forests and semi-natural areas decreased. The proportions of wetlands and water bodies did not give any significant correlation with the water quality scale.

Table 4.6.2.1. *Spearman rank correlation coefficients between water quality scale (1 - high, 2 – high/good, 3 – good, 4 – good/moderate, 5 – moderate) and the percentages of the basic CORINE land cover classes. Significant (p<0.05) correlations highlighted.*

Type of pressure	Rivers	Lakes	Coastal waters	Transitional waters
Artificial surfaces	**0.10**	**0.14**	**0.33**	0.04
Agricultural areas	**0.18**	**0.22**	0.11	-0.16
Forests and semi-natural areas	**-0.23**	**-0.16**	**-0.26**	0.27
Wetlands	0.05	-0.06	0.12	0.09
Water bodies	-0.02	-0.07	-0.16	-0.07

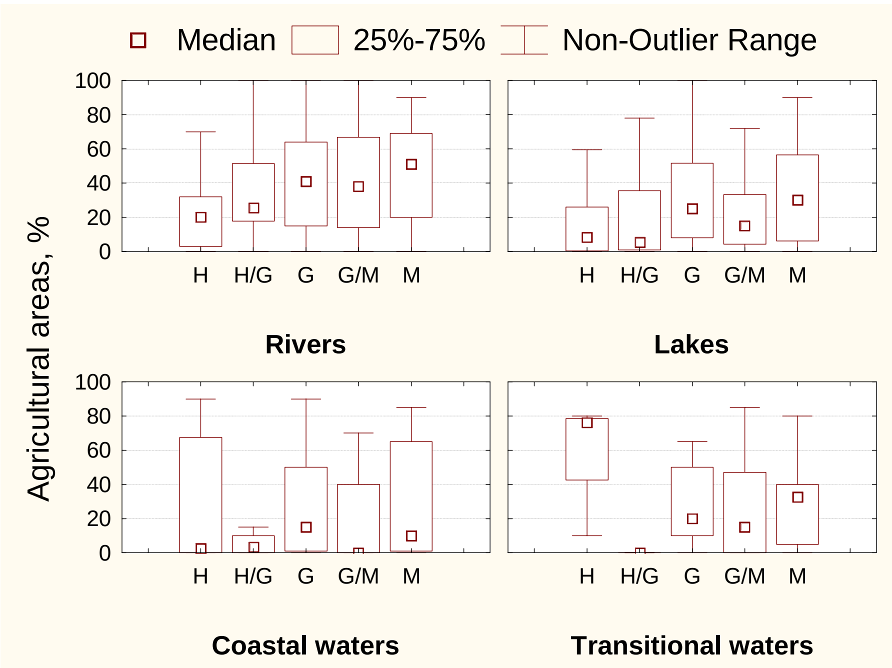


Fig. 4.6.2.2. Changes in the percentage of agricultural lands in the catchment area along the water quality axes in the intercalibration register. H – 'high', G – 'good', M – 'moderate'

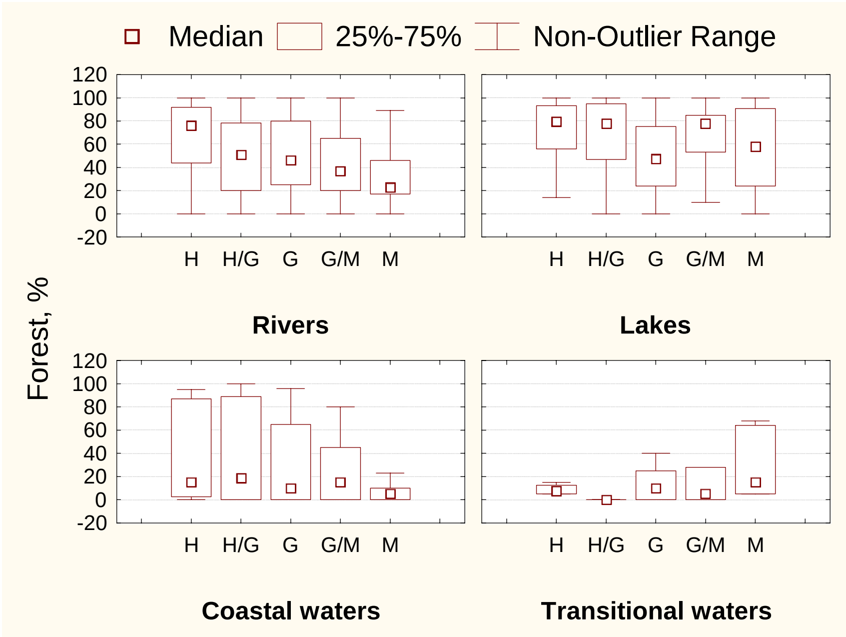


Fig. 4.6.2.3. Changes in the percentage of forests in the catchment area along the water quality axes in the intercalibration register. H – 'high', G – 'good', M – 'moderate'

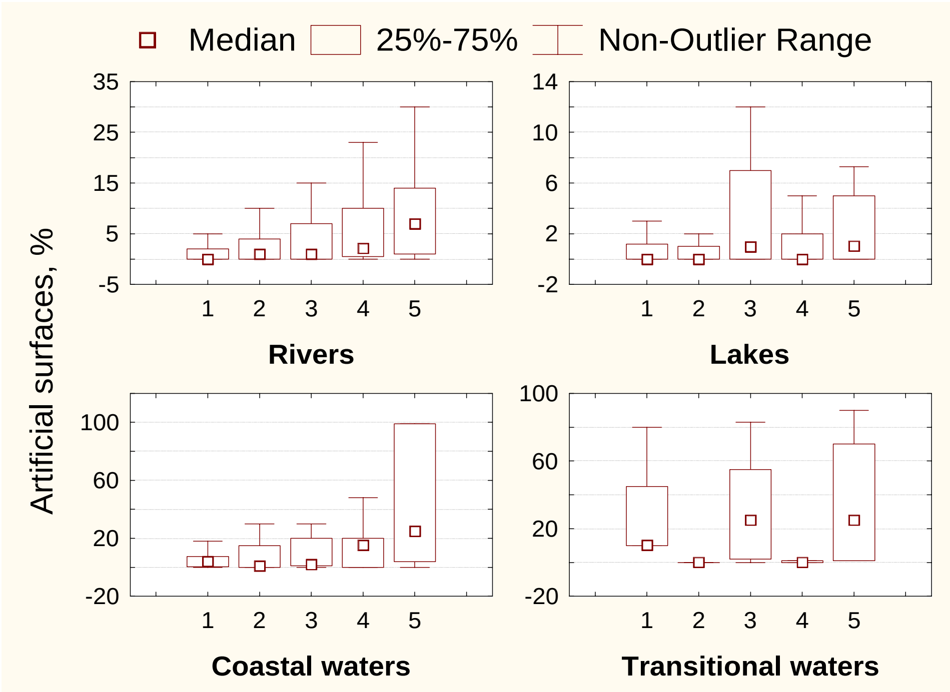


Fig. 4.6.2.4. Changes in the percentage of artificial surfaces in the catchment area along the water quality axes in the intercalibration register. H – 'high', G – 'good', M – 'moderate'

4.6.3. Relationship between water quality parameters and the estimated quality classes of lakes

Additional water quality parameters like Secchi depth, maximum chlorophyll concentration, average and maximum total phosphorus concentration allowed an in depth analysis of the water quality scale for lakes. Despite the existence of a large number of statistically significant correlations, the relationships were generally weak and scattered. The wide scatter could be also expected, as all lake types were included in the analysis. Search for type parameters that could decrease the variation lead us to the mean depth that explained a substantial part of it (Fig. 4.6.3.1 – 4.6.3.3). We included the mean depth as a categorical variable with a breaking point at 3 m that was supposed to separate shallow lakes (<=3 m) with potential macrophyte dominance from deeper lakes (>3m).

Table 4.6.3.1. *Numeric variables correlating significantly ($p<0.05$, spearman rank correlation) with the scale of estimated water quality for lakes (1 - high, 2 – high/good, 3 – good, 4 – good/moderate, 5 – moderate)*

Variable	**Spearman rank correlation coefficient**
Secchi depth	-0.37
Maximum chlorophyll concentration	0.49
Maximum total phosphorus concentration	0.27
Average total phosphorus concentration	0.44
Organic loading (arbitrary scale 1-4)	0.37
Nutrient loading (arbitrary scale 1-4)	0.48
Artificial surfaces % in the catchment	0.14
Agricultural areas, % in the catchment	0.22
Forests & semi-natural areas, % in the catchment	-0.16
Longitude	-0.13
Mean depth	-0.13

Secchi depth differed significantly between these two groups being by 1-2 meters smaller in shallow lakes than in deeper lakes of the same quality class

(Fig. 4.6.3.1). Fisher LSD test (Statistica for Windows 6.0) showed that among single groups the difference was significant for those, which quality was indicated as good or good/moderate. There are at least two possible reasons that could explain the difference:

1. In shallow lakes, especially in those having a large surface area, bottom sediments are resuspended by wave action. The larger suspended matter content is characteristic of shallow lakes and as it is natural, it does not decrease the ecological water quality.
2. In shallow lakes with transparent water the Secchi disk reaches the bottom before it would disappear from the sight because of light attenuation. One can suspect that in such cases often the depth of the site is erroneously registered as the Secchi depth.

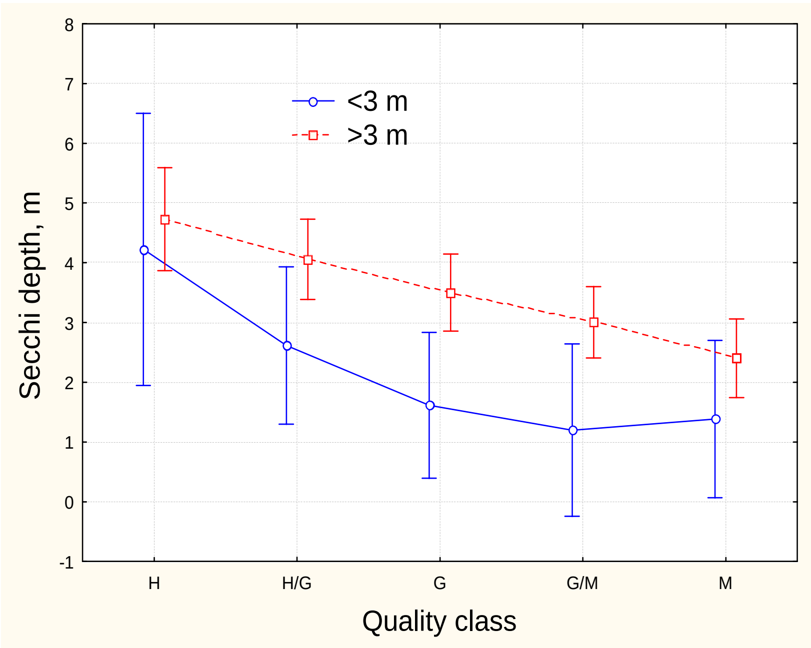


Fig. 4.6.3.1. Changes in average Secchi depth in shallow (mean depth <3 m) and deep (>3 m) lakes along the water quality axes. Whiskers indicate the 95% confidential interval. H – 'high', G – 'good', M – 'moderate'

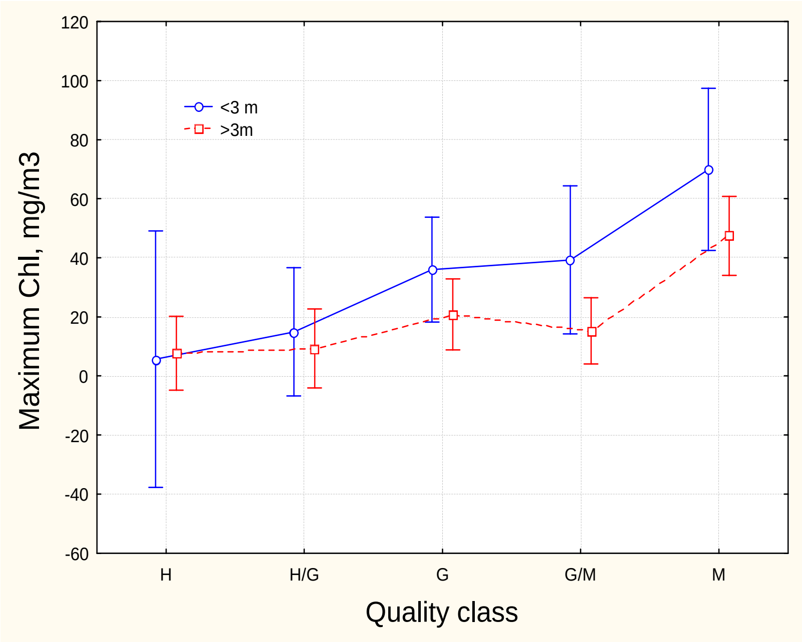


Fig. 4.6.3.2. Changes in the maximum chlorophyll a concentration in shallow (mean depth <3 m) and deep (>3 m) lakes along the water quality axes. Markers show the averages and whiskers indicate the 95% confidential interval; H – 'high', G – 'good', M – 'moderate'

The **maximum chlorophyll concentration** differed significantly between deep and shallow lakes and also the slopes of the relationships with the quality scale were different (Fig. 4.6.3.2), but within single quality groups the differences remained non-significant. It is remarkable that there were no differences in maximum chlorophyll in the quality class "high" but the differences increased gradually with the degrading water quality. The large scatter of data within the group of shallow lakes could be partly caused by the different role of macrophytes within these lakes. At the same phosphorus level shallow lakes can be dominated either by macrophytes or by phytoplankton. These two alternative stable states contrast strongly in terms of chlorophyll content and water transparency.

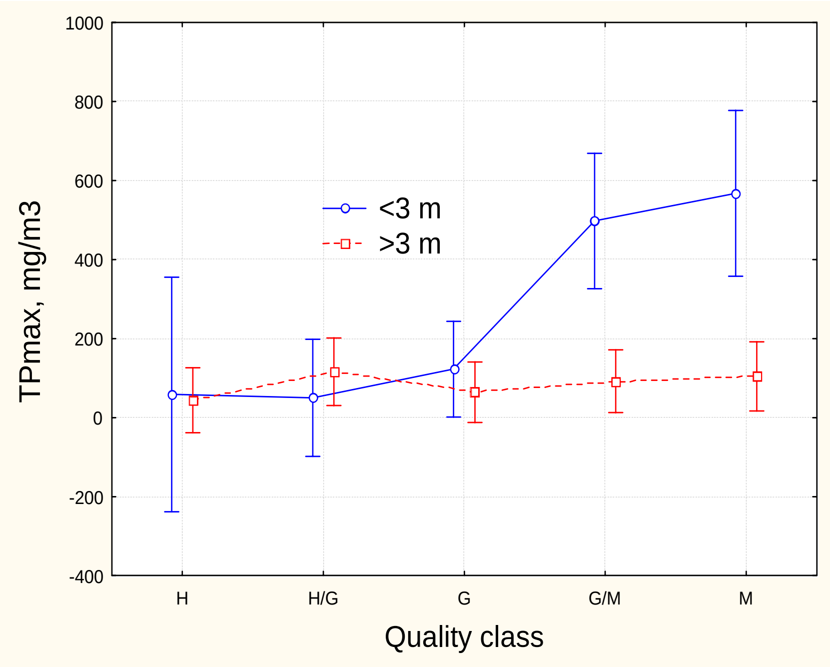


Fig. 4.6.3.3. Changes in the maximum total phosphorus concentration in shallow (mean depth <3 m) and deep (>3 m) lakes along the water quality gradient. Markers show the averages and whiskers indicate the 95% confidential interval; H – 'high', G – 'good', M – 'moderate'

There were only minor changes in the **maximum total phosphorus concentration** (TPmax) of lakes from high to good quality class (Fig. 4.6.3.3). In deeper lakes the median TPmax varied between 44 and 116 mg m^{-3} and this variable did not correlate at all with the estimated water quality. In shallow lakes, on the contrary, TPmax was one of the best water quality descriptors and differed significantly between the two quality class boundaries (H/G & G/M) on which the WFD intercalibration is focused on.

4.7. Availability of reference conditions

Chapter 6 of the Metadata Questionnaire concerned the availability of the reference conditions[14] (RC) for estimating water quality. For each of the 23 quality elements three possible answers were included: "Yes", "No", and "No answer yet". In the case of a positive answer, the next question concerned the method used to derive the reference conditions. Six different options were offered in the questionnaire:

[14] The methods are described in detail in the Guidance documents of reference conditions (outcomes of WG 2.3 – REFCOND Rivers and Lakes – Typology, Reference Conditions and Classification Systems and 2.4. Guidance on Typology, Reference Conditions and Classification Systems for Transitional and Coastal Waters)

A - reference sites

B - historical data

C - paleo-biological methods

D – modelling

E - expert opinion

F - curve fitting

First we examined what percentage of the reported 385 lake sites, the 883 river sites, 190 coastal sites and the 42 transitional sites had defined reference conditions for some of the quality elements. We plotted the results as bar charts by water categories (Figs. 4.7.1.3, 4.7.2.3, 4.7.3.3. & 4.7.3.7) where each of the bars was indicative for data availability for one of the 23 quality elements. We also mapped the availability of the reference conditions for some basic quality elements (e.g. basic nutrients, chlorophyll, phytoplankton and benthic macroinvertebrates) in order to obtain information of the geographical distribution of such sites in Europe. Finally we overviewed the statistics of the used methods from A to F for each quality element showing the results in pie charts.

4.7.1. Lakes

The availability of RC differed largely from site to site. There were 90 lakes for which no RC were available (Fig. 4.7.1.1) and there were no lakes for which RC had been worked out for all 23 different quality elements (QE). A maximum number of 20 QE with defined RC per site was reported from two sites from the Netherlands. The elaboration level of RC was rather country specific. So, for example, the Netherlands,

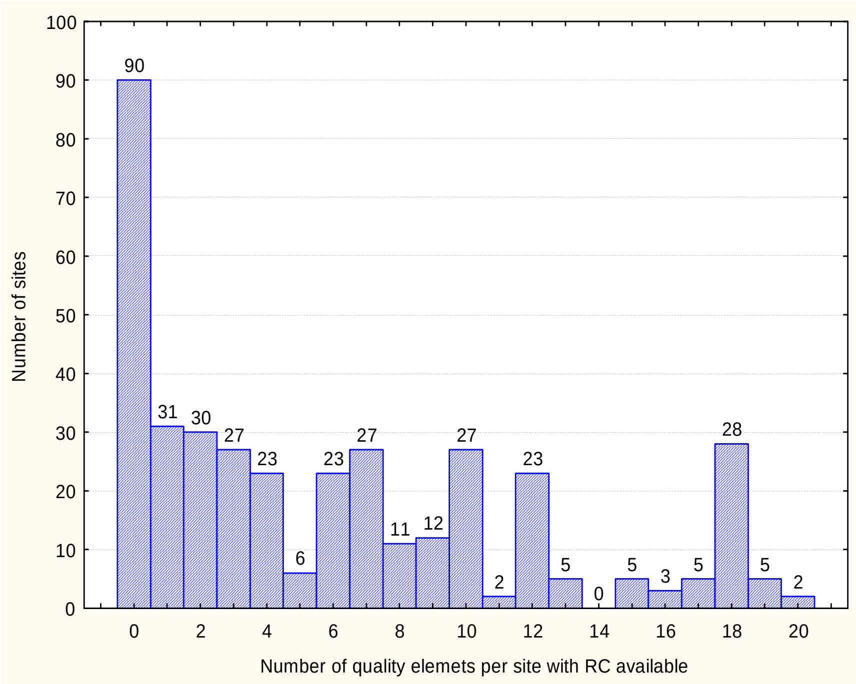


Fig. 4.7.1.1. Frequency histogram showing the number of lake sites with different levels of reference conditions availability

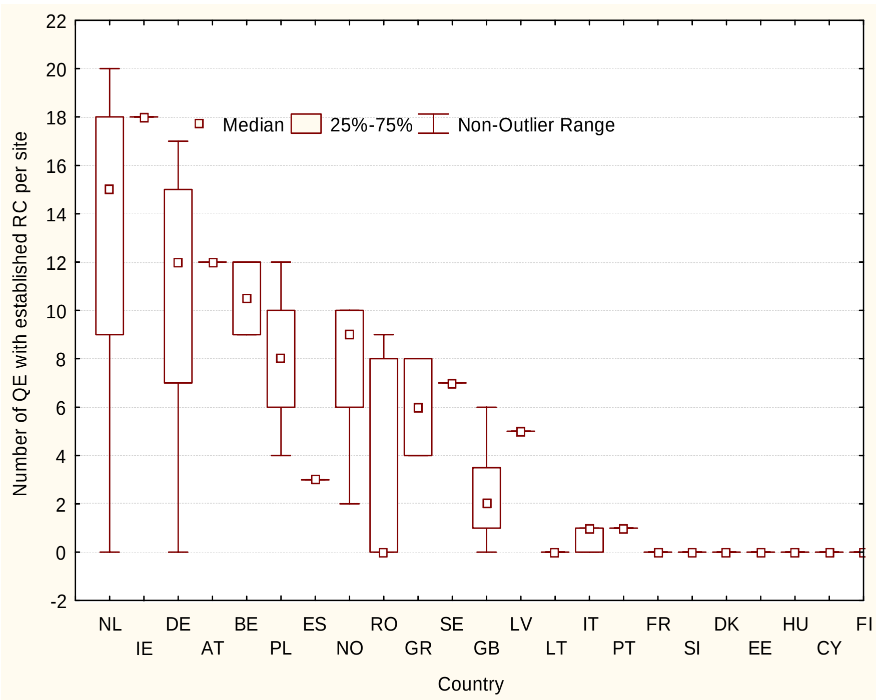


Fig. 4.7.1.2. Whiskers plot showing the ranges of reference conditions availability by countries for lakes included in the Final Intercalibration Register

Ireland, Germany, Austria and Belgium had indicated the availability of RC for more than ten quality elements per sites (Fig. 4.7.1.2) while no RC were available for the sites from France, Slovenia, Denmark, Estonia, Hungary, Cyprus, and Finland.

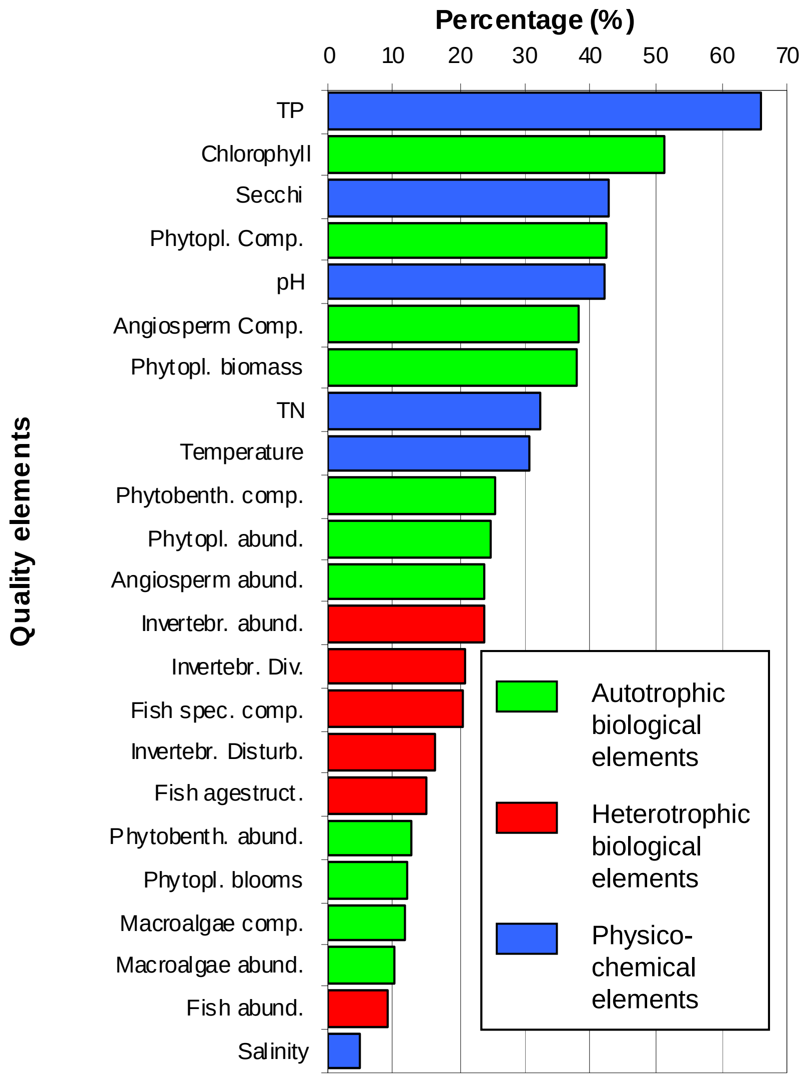


Fig. 4.7.1.3. Percentage of lake sites in the Final Intercalibration Register with reference conditions available for different quality elements

Looking the availability of RC by single quality elements (Fig. 4.7.1.3), it becomes evident that the knowledge on physicochemical QE and the autotrophic QE (plants in the broad sense) in lakes is much better compared with the knowledge on benthic invertebrates and fish (heterotrophic QE). For 2/3 of lakes included in the Final Intercalibration Register, RC have been established for total phosphorus, for one half

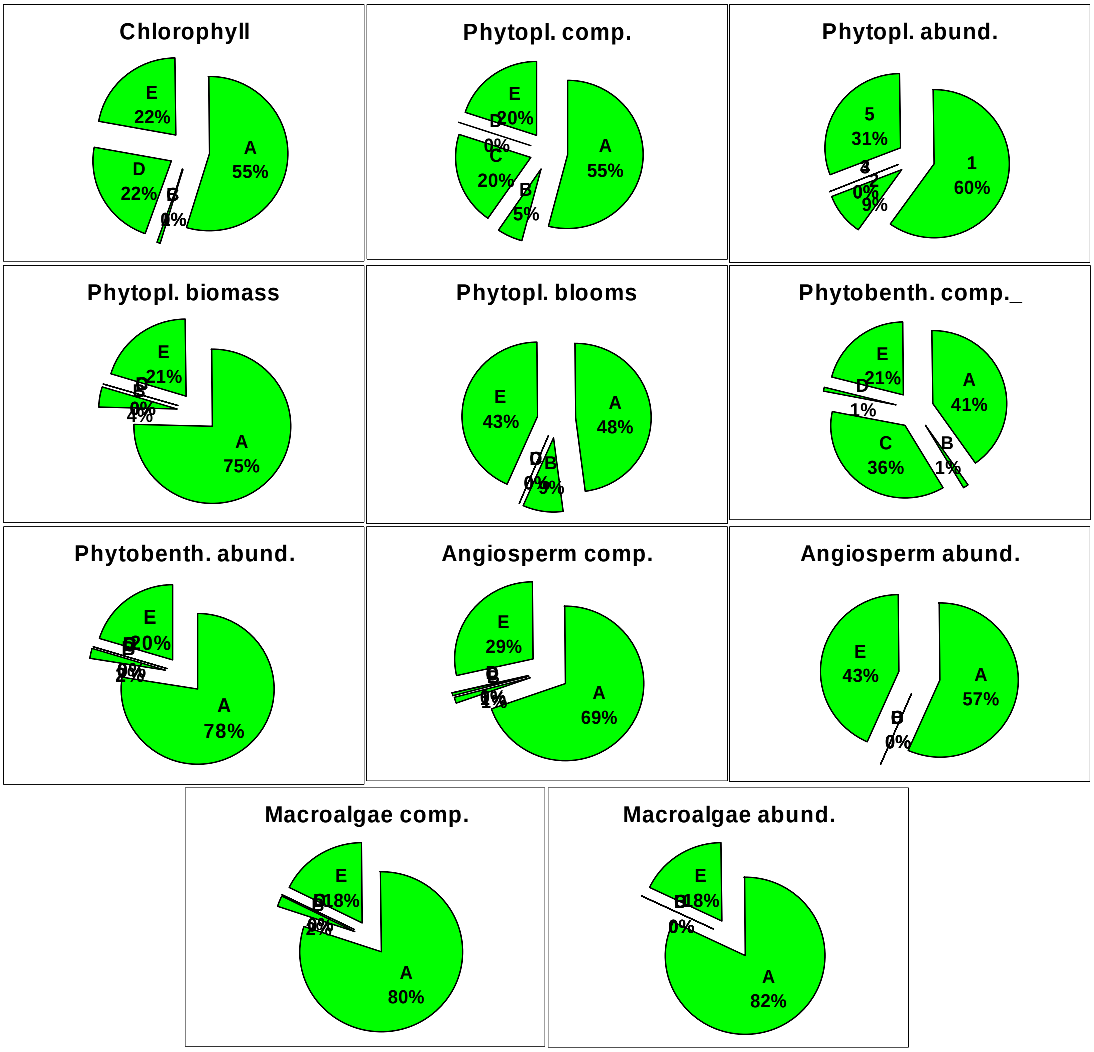


Fig. 4.7.1.4. Methods used to define reference conditions for quality elements of autotrophs in lakes. A – reference sites, B – historical data, C – paleo-biological methods, D - modelling, E – expert opinion.

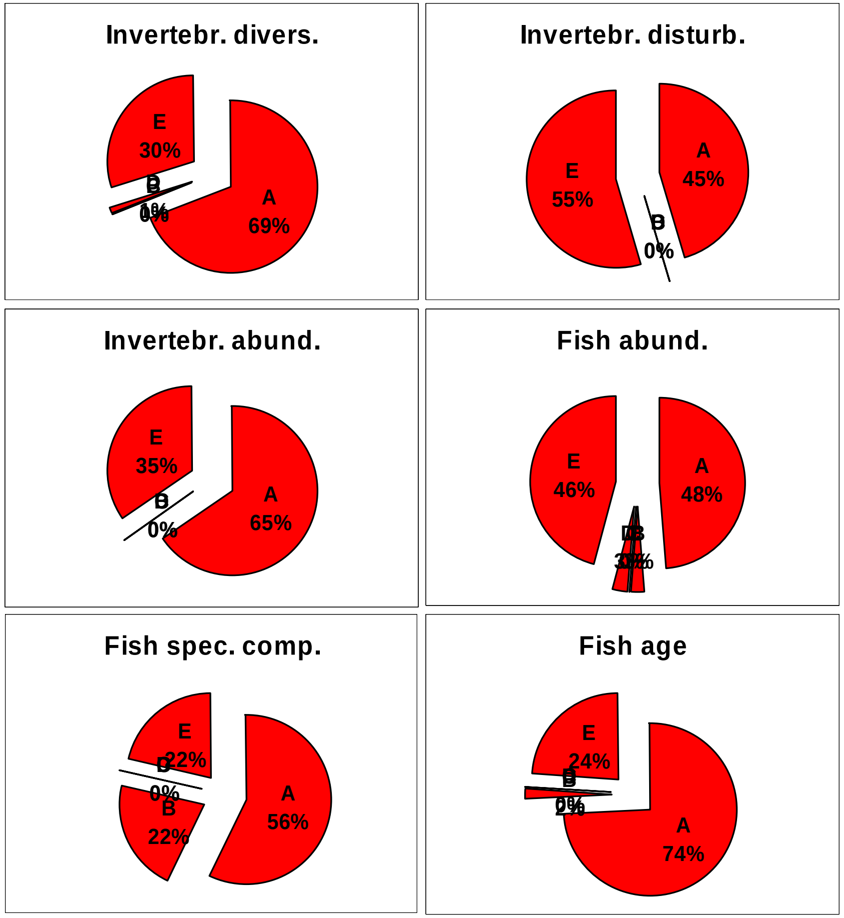


Fig. 4.7.1.5. Methods used to define reference conditions for quality elements of heterotrophs in lakes. A – reference sites, B – historical data, C – paleo-biological methods, D - modelling, E – expert opinion.

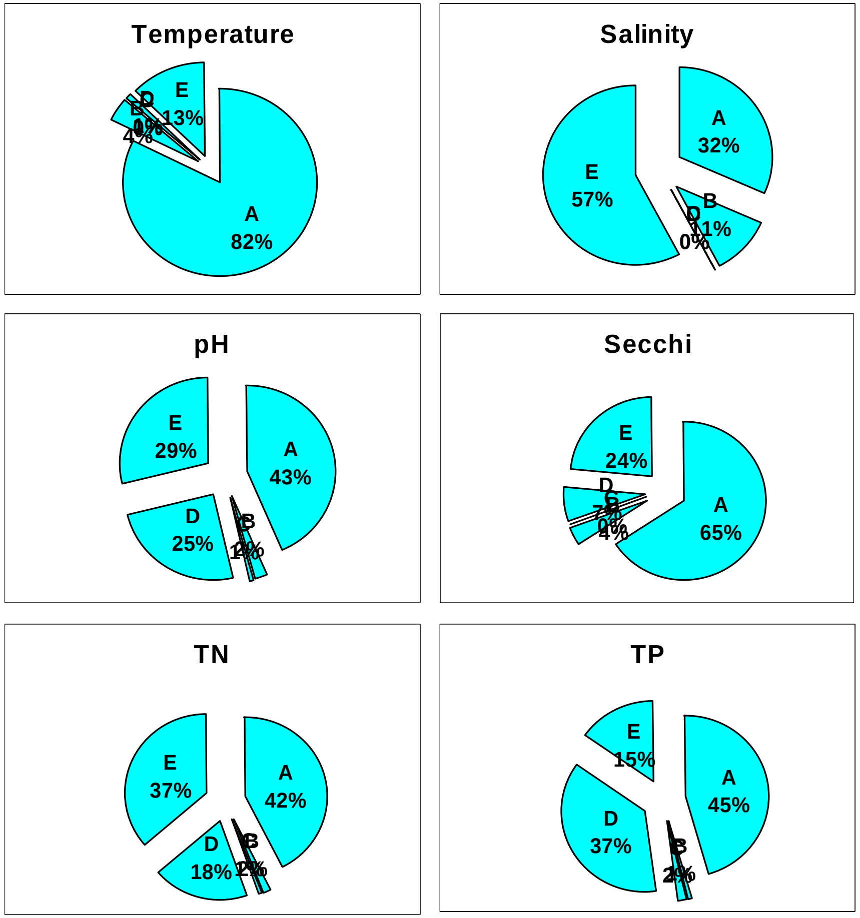


Fig. 4.7.1.6. Methods used to define reference conditions for physico-chemical quality elements in lakes. A – reference sites, B – historical data, C – paleo-biological methods, D - modelling, E – expert opinion.

of lakes for chlorophyll and for more than 1/3 of lakes for Secchi depth, pH, macrophyte composition and phytoplankton biomass. At the same time, RC for invertebrate and fish parameters have been established rather rarely (<20%) in lakes.

Also the availability of RC for different QE was rather country specific (App. 3, I-VI). So, for example, Sweden and Italy had established RC for total phosphorus in most of their lakes while no RC were available for chlorophyll. An opposite situation could be found in Portugal. Well-established RC for both TP and chlorophyll were reported by Ireland, Spain, Austria, and The Netherlands.

The different methods used to establish RC for lakes are presented in Figs. 4.7.1.4 – 4.7.1.6. On average they sequenced in the following order:

- For physico-chemical elements: *reference site* > *expert opinion* > *modelling* > *historical data* (paleo-biological and curve fitting methods were not applied);
- For autotrophic biological elements: *reference site* > *expert opinion* > *historical data* > *modelling* > *paleo-biological methods* (curve fitting was not applied);
- For heterotrophic biological elements: *reference site* > *expert opinion* > *modelling* > *historical data* (paleo-biological and curve fitting method were not applied);

Geographic distribution of the availability of RC for some of the basic quality elements for lakes is presented in Appendix 3 (I-VI).

4.7.2. Rivers

In the case of 1/3 of rivers (305 of the total 883 sites) no RC were available (Fig. 4.7.2.1). A large number of sites (181) had established RC for just three quality elements related in most cases to benthic macroinvertebrates. Reference conditions for the diversity, the composition, and the abundance of the invertebrates were available in more than 50% of sites and for pH, nutrients, and temperature in 20-40% of sites (Fig. 4.7.2.3). For all the rest of the quality elements RC were available in less than 20% of cases.

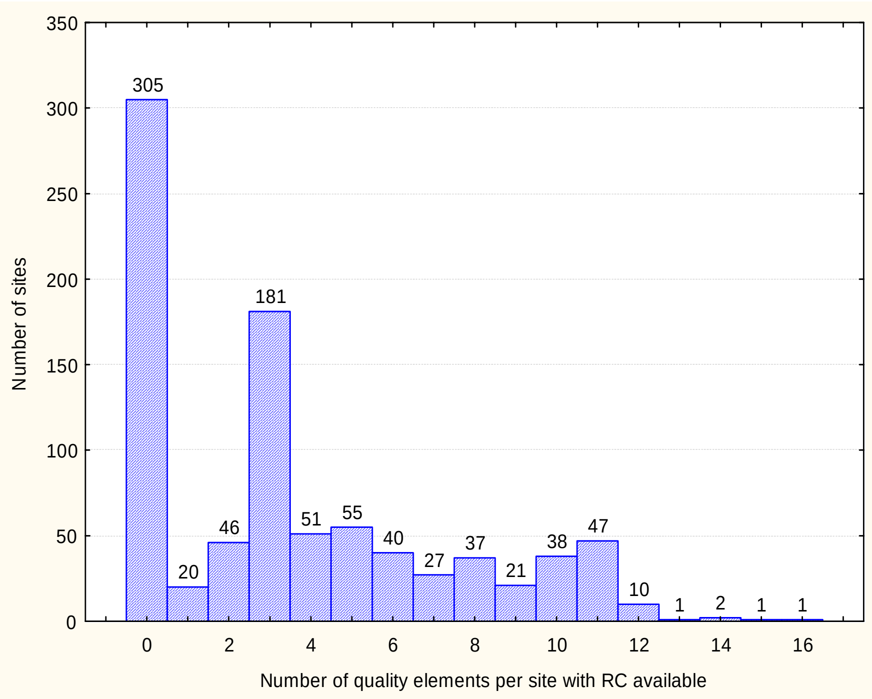


Fig. 4.7.2.1. Frequency histogram showing the number of river sites with different levels of reference conditions availability

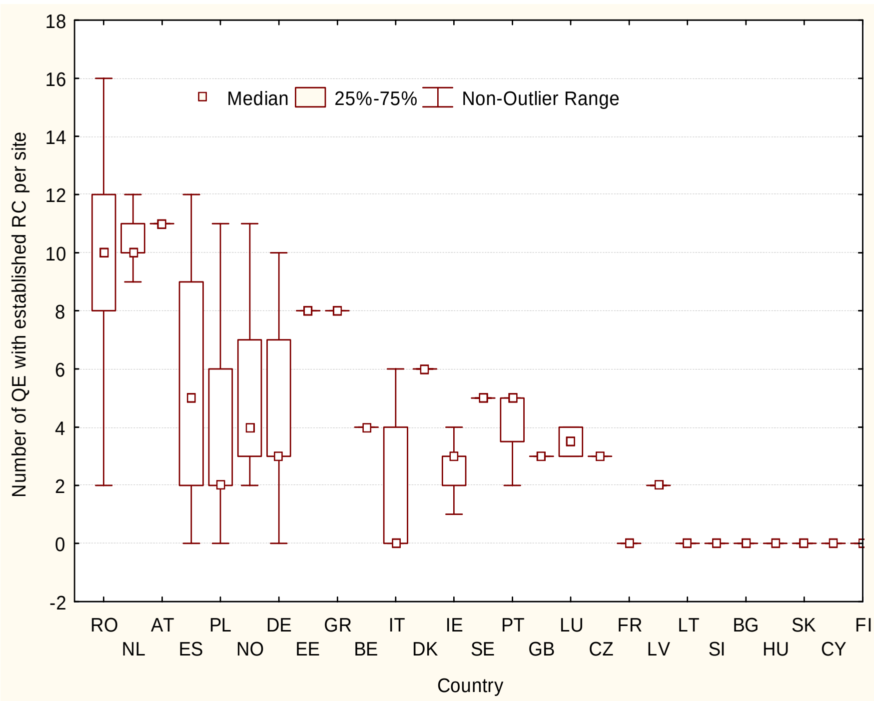


Fig. 4.7.2.2. Box and whiskers plot showing the ranges of reference conditions availability by countries for rivers included in the Final Intercalibration Register

Romania, The Netherlands and Austria have established RC for ten or more quality elements per site (Fig. 4.7.2.2). No RC for rivers were set by eight countries (FR, LT, SI, BG, HU, SK, CY FI).

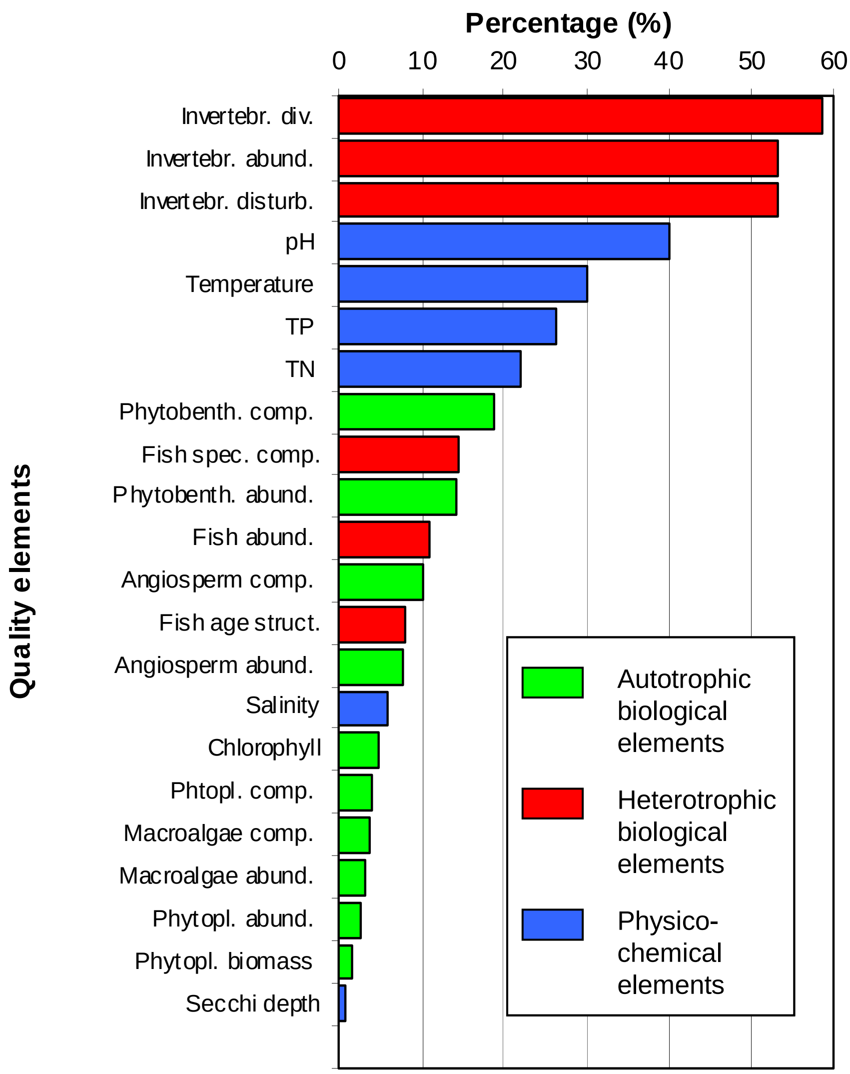


Fig. 4.7.2.3. Percentage of river sites in the Final Intercalibration Register with reference conditions available for different quality elements

The different methods used to establish RC for rivers are presented in Figs. 4.7.2.4 – 4.7.2.6. On average they sequenced in the following order:

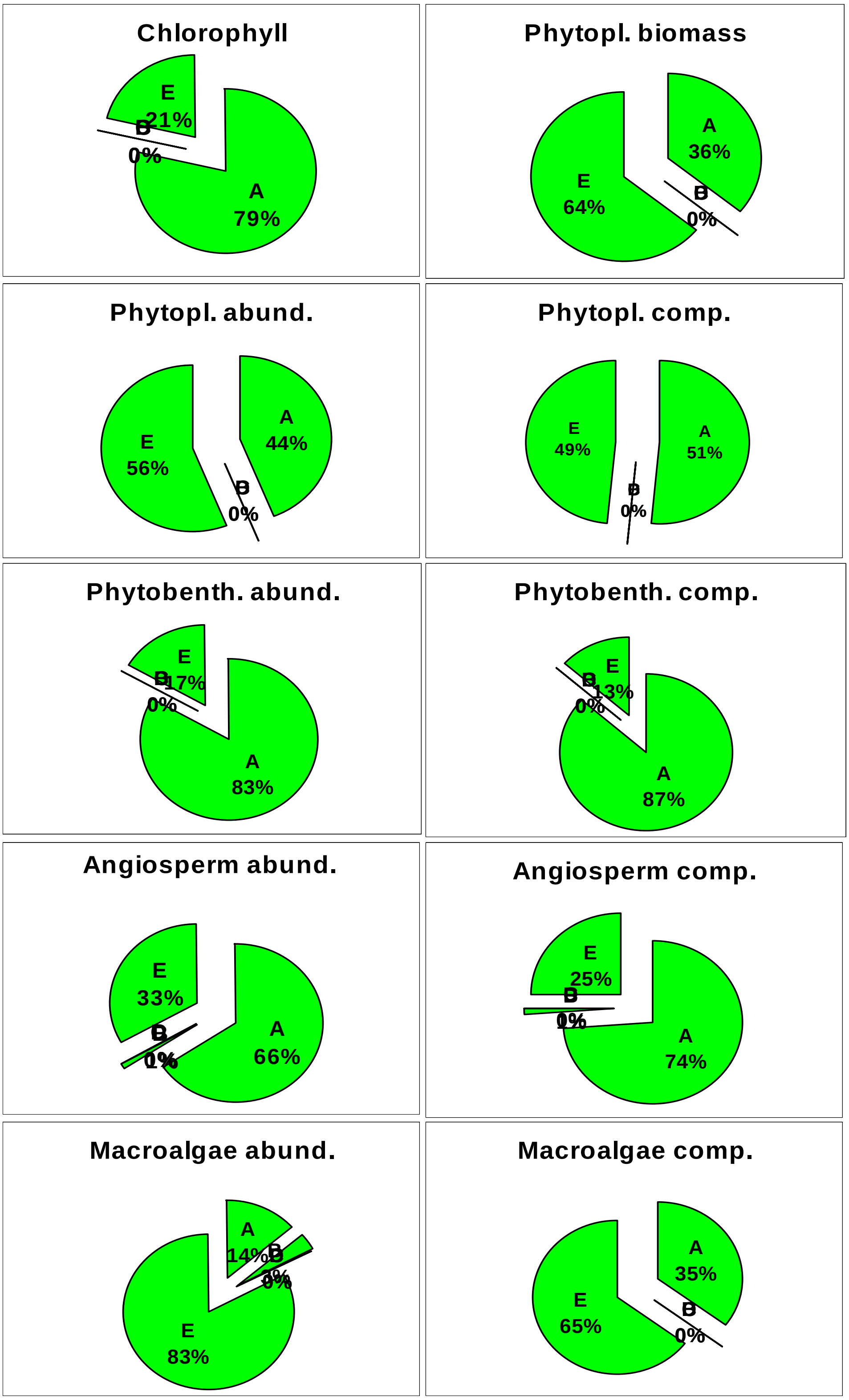


Fig. 4.7.2.4. Methods used to define reference conditions for quality elements of autotrophs in rivers. A – reference sites, B – historical data, C – paleo-biological methods, D - modelling, E – expert opinion.

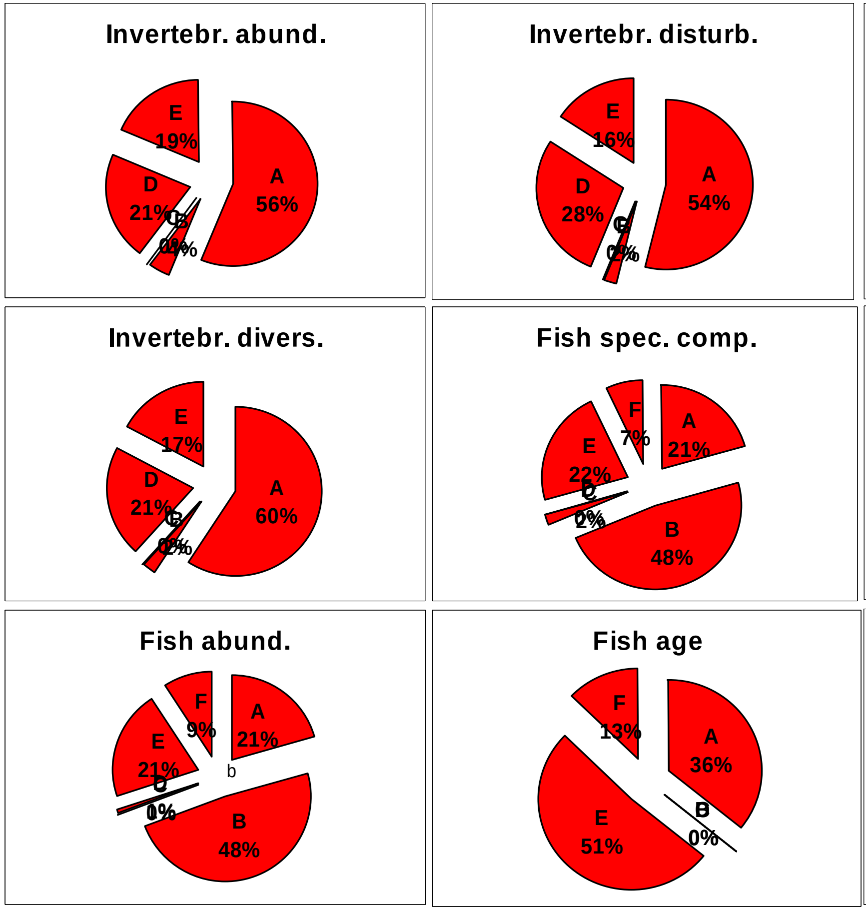


Fig. 4.7.2.5. Methods used to define reference conditions for quality elements of heterotrophs in rivers. A – reference sites, B – historical data, C – paleo-biological methods, D - modelling, E – expert opinion.

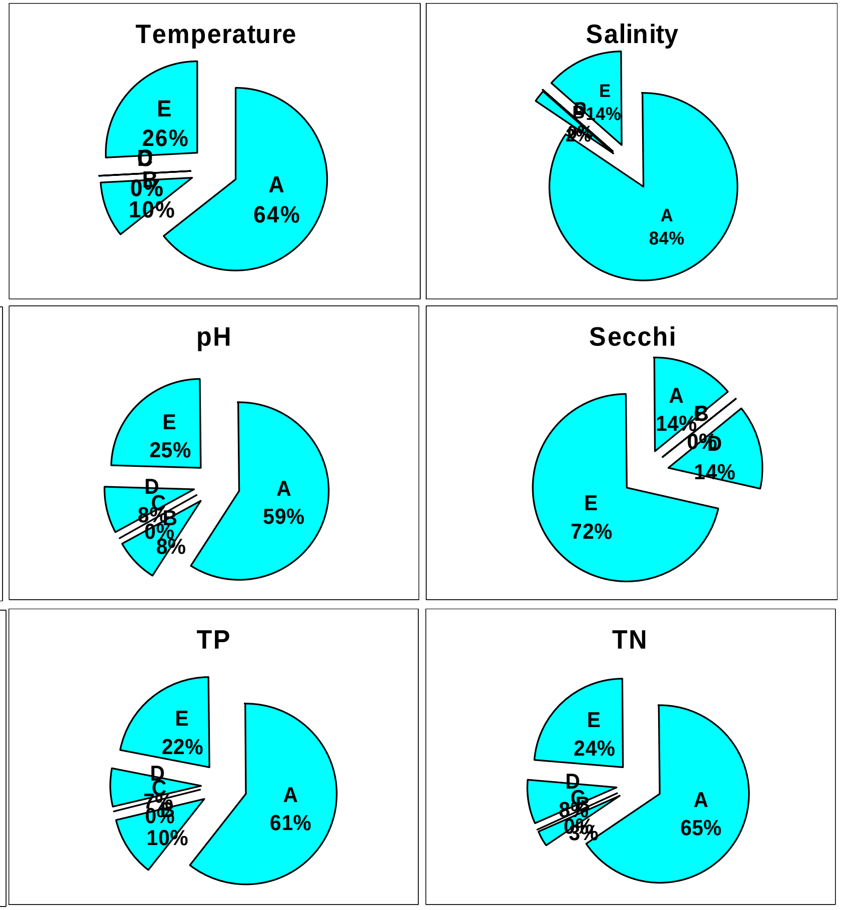


Fig. 4.7.2.6. Methods used to define reference conditions for physico-chemical quality elements in rivers. A – reference sites, B – historical data, C – paleo-biological methods, D - modelling, E – expert opinion.

- For physico-chemical quality elements: *reference site* > *expert opinion* > *modelling* > *historical data* > *paleo-biological methods* (curve fitting was not applied);

- For autotrophic biological quality elements: *reference site* > *expert opinion* > *historical data* > *modelling* > *paleo-biological methods* (curve fitting was not applied);
- For heterotrophic biological quality elements: *reference site* > *expert opinion* > *modelling* > *historical data* > *paleo-biological methods* > *curve fitting.*

Geographic distribution of the availability of RC for some of the basic quality elements for rivers is presented in Appendix 3 (VII-XII).

4.7.3. Coastal waters and transitional waters

In the coastal and transitional sites, neither the physico-chemical, nor the biological elements had reference conditions for more than 25% of the altogether 232 sites (Figs. 4.7.3.3. and 4.7.3.7). At both coastal and transitional sites the majority of RC were established for physico-chemical parameters (nutrients, temperature, salinity) and for benthic macroinvertebrates. Among autotrophic quality elements chlorophyll had the biggest number of RC available. Reference conditions for phytobenthos and macroalgae were established for less than 15% of coastal sites and for less than 10% of transitional sites. RC for phytobenthos and fish age structure were missing from all transitional water sites.

For the majority of sites (71% of coastal and 79% of transitional sites) there were no RC established at all (Fig. 4.7.3.1 and 4.7.3.7). The maximum number of quality elements per site with RC available was 16 among coastal waters and 18 among transitional waters. Thirteen countries of 21 had established RC for some quality elements, while RC were totally missing for coastal and transitional waters in United Kingdom, Ireland, Portugal, and Lithuania (Fig. 4.7.3.2 and 4.7.3.8).

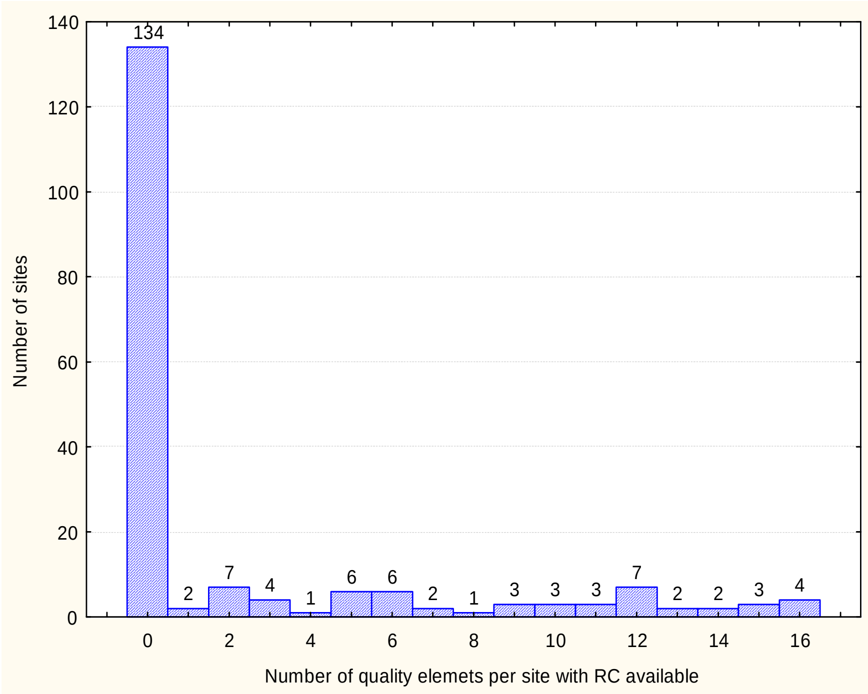


Fig. 4.7.3.1. Frequency histogram showing the number of coastal water sites with different levels of reference conditions availability

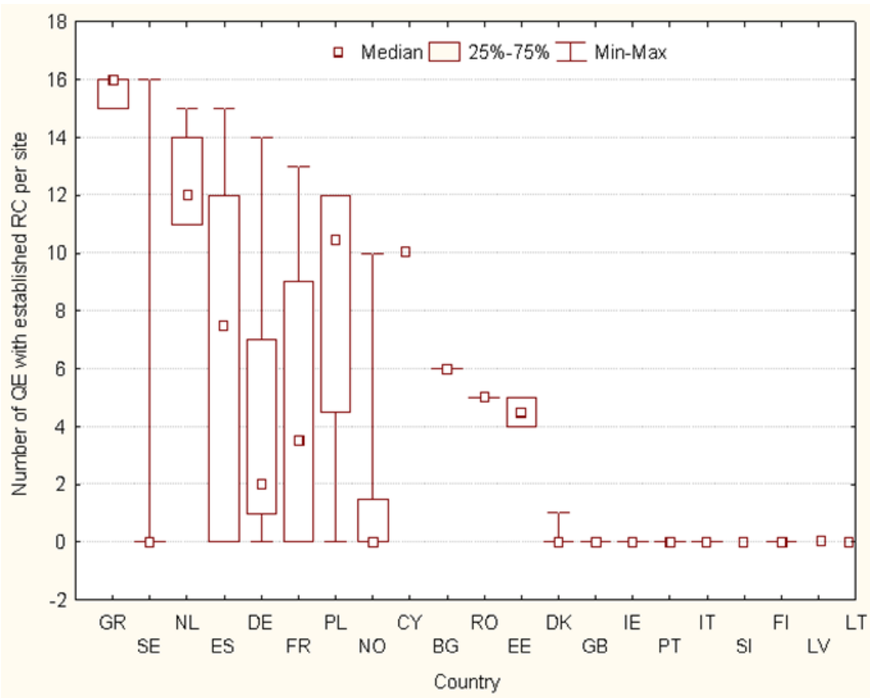


Fig. 4.7.3.2. Box and whiskers plot showing the ranges of reference conditions availability by countries for coastal waters included in the Final Intercalibration Register

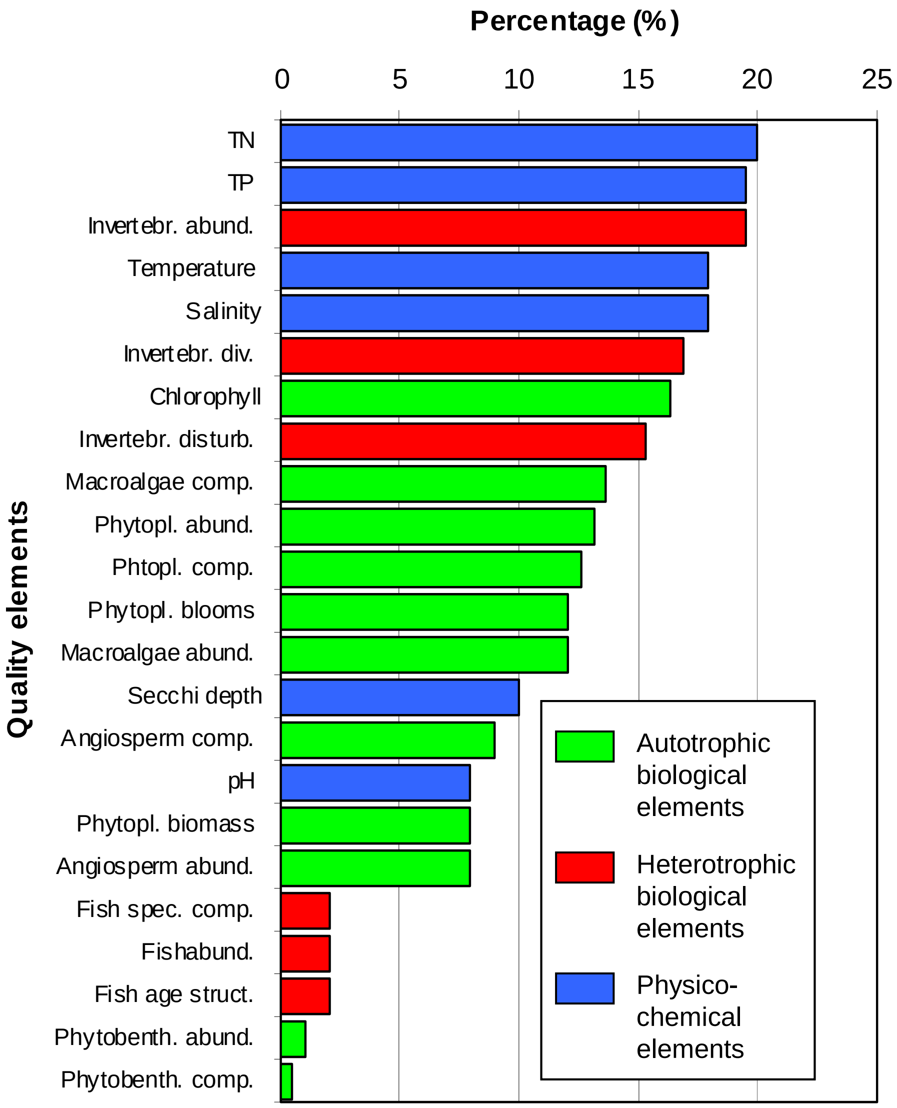


Fig. 4.7.3.3. Percentage of coastal sites in the Final Intercalibration Register with reference conditions available for different quality elements

The distribution of the different methods used for establishing RC in coastal waters are showed in Figs. 4.7.3.4 – 4.7.3.6. The obtained average sequences of different methods in were as follows:

- For physico-chemical elements: *historical data* > *reference site* > *expert opinion* > *modelling* > *paleo-biological methods* (curve fitting was not applied);

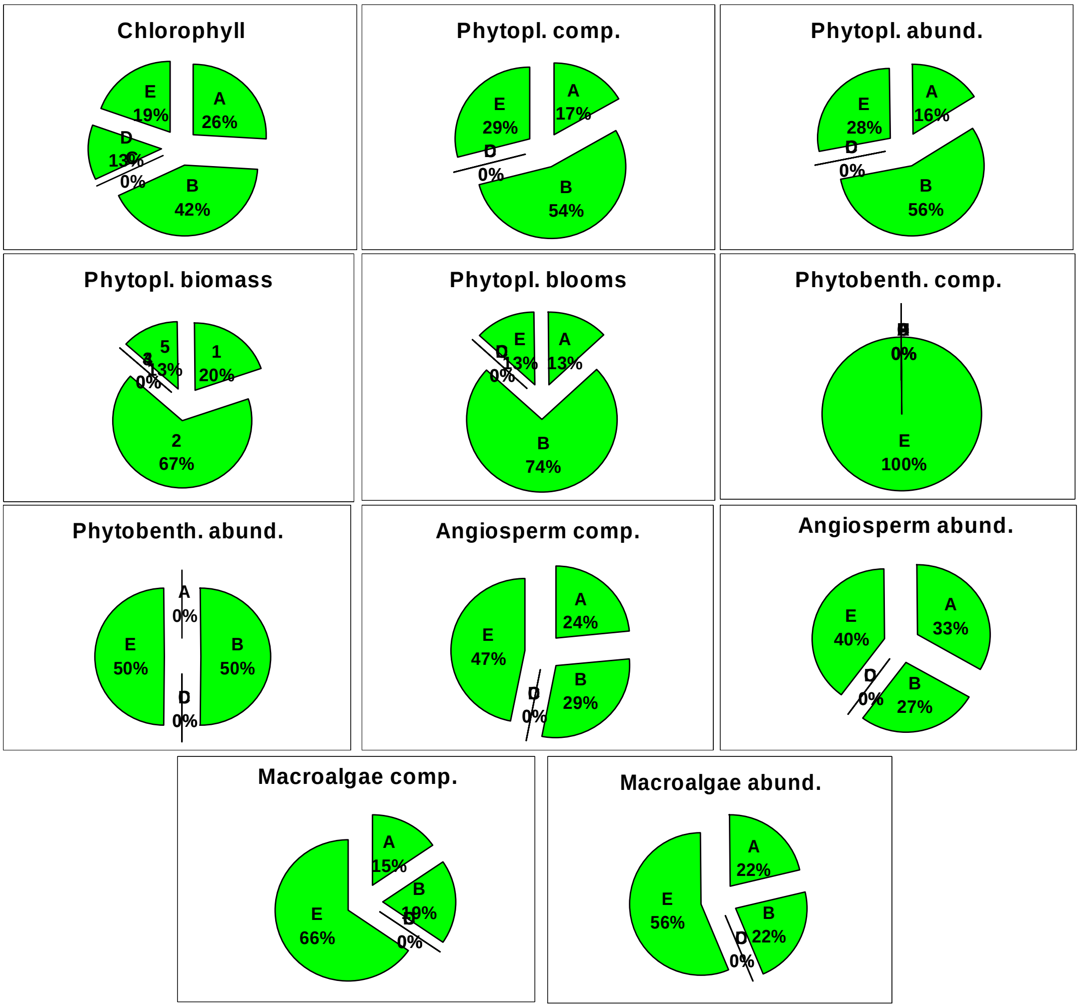


Fig. 4.7.3.4. Methods used to define reference conditions for quality elements of autotrophs in coastal waters. A – reference sites, B – historical data, C – paleo-biological methods, D - modelling, E – expert opinion.

- For autotrophic biological elements: *historical data* > *expert opinion* > *reference site* > *modelling* (paleo-biological and curve fitting methods were not used);
- For heterotrophic biological elements: *reference site* > *historical data* > *expert opinion* > *paleo-biological methods* (modelling and curve fitting were not used);

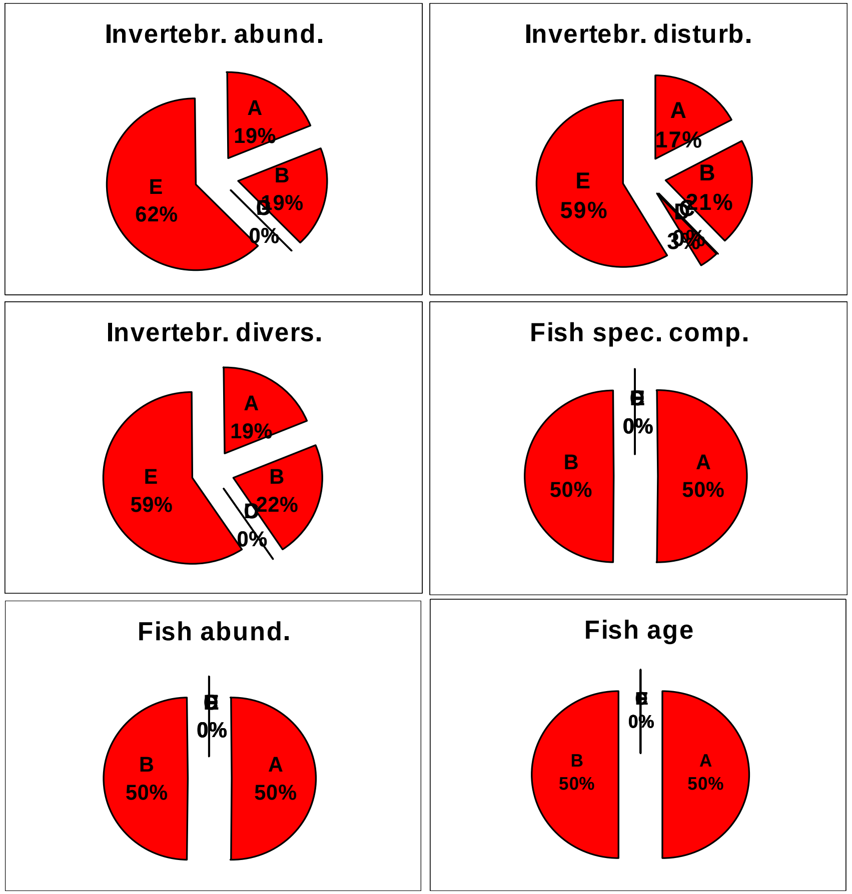


Fig. 4.7.3.5. Methods used to define reference conditions for quality elements of heterotrophs in coastal waters. A – reference sites, B – historical data, C – paleo-biological methods, D - modelling, E – expert opinion.

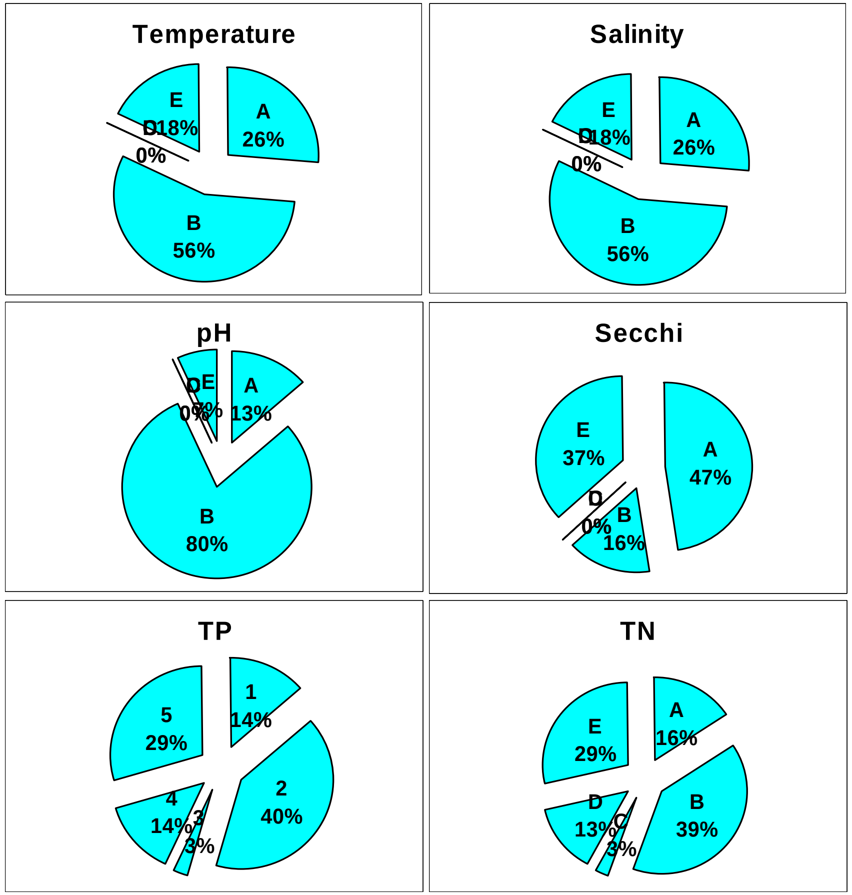


Fig. 4.7.3.6. Methods used to define reference conditions for physico-chemical quality elements in coastal waters. A – reference sites, B – historical data, C – paleo-biological methods, D - modelling, E – expert opinion.

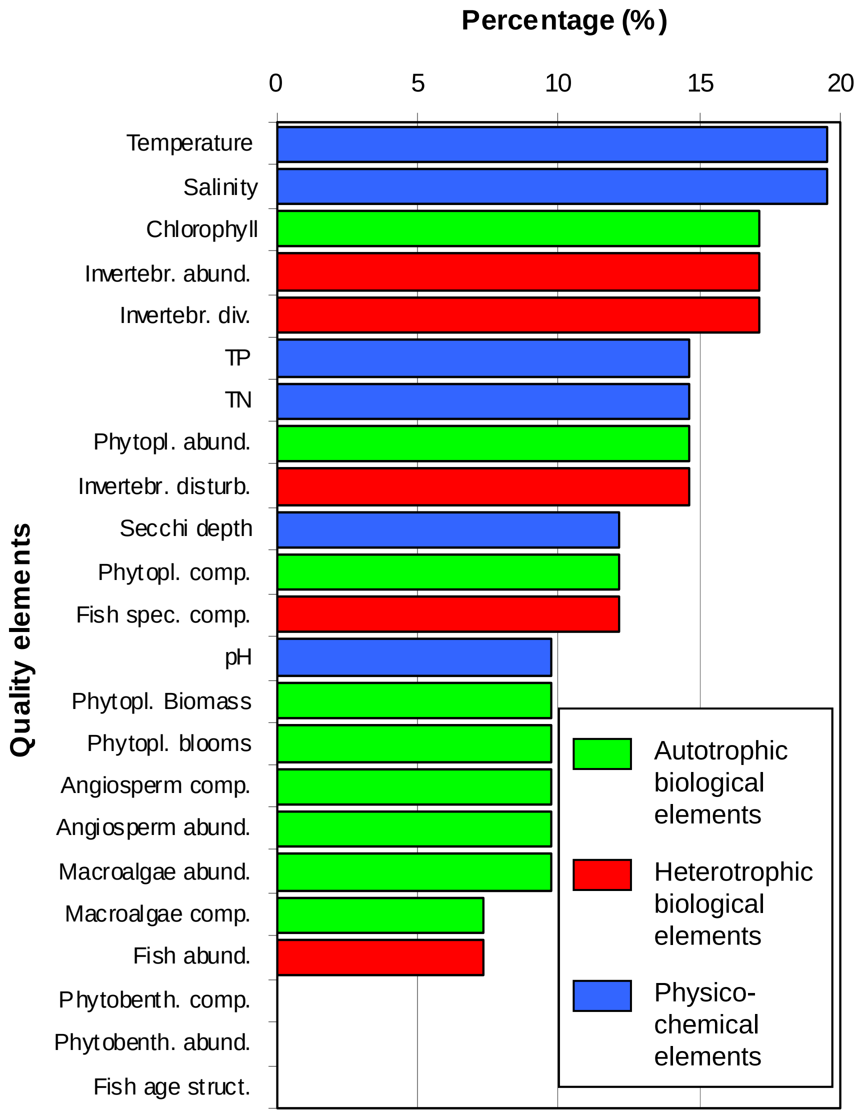


Fig. 4.7.3.7. Percentage of transitional water sites in the Final Intercalibration Register with reference conditions available for different quality elements

For transitional waters the different methods for establishing RC (Fig. 54-56) ordered in the following sequence:

- For physico-chemical elements: *historical data* > *reference site* > *expert opinion* > *modelling* (paleo-biological and curve fitting methods were not used);

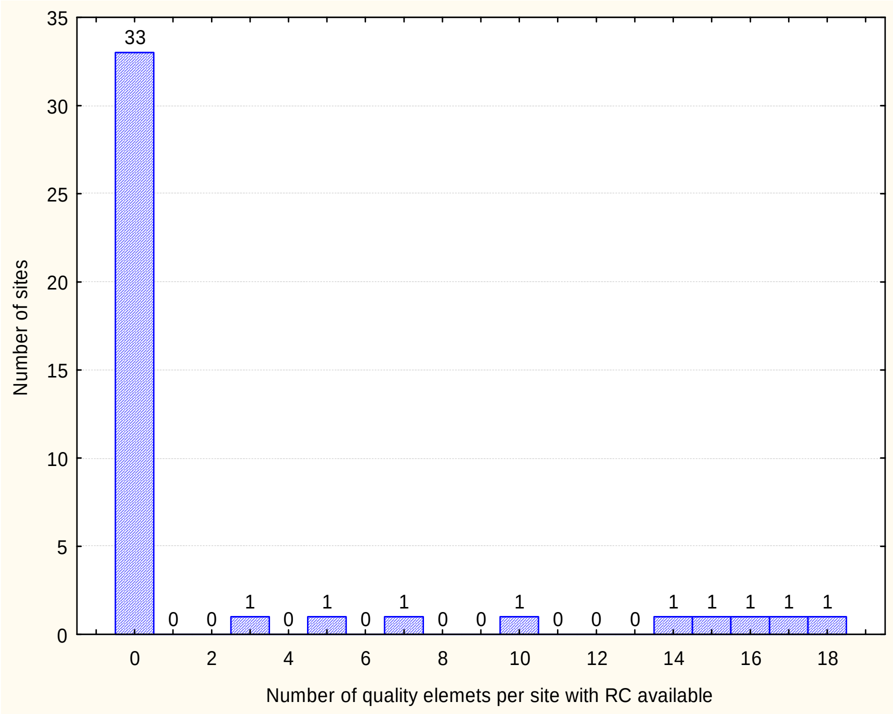


Fig. 4.7.3.8. Frequency histogram showing the number of transitional water sites with different levels of reference conditions availability

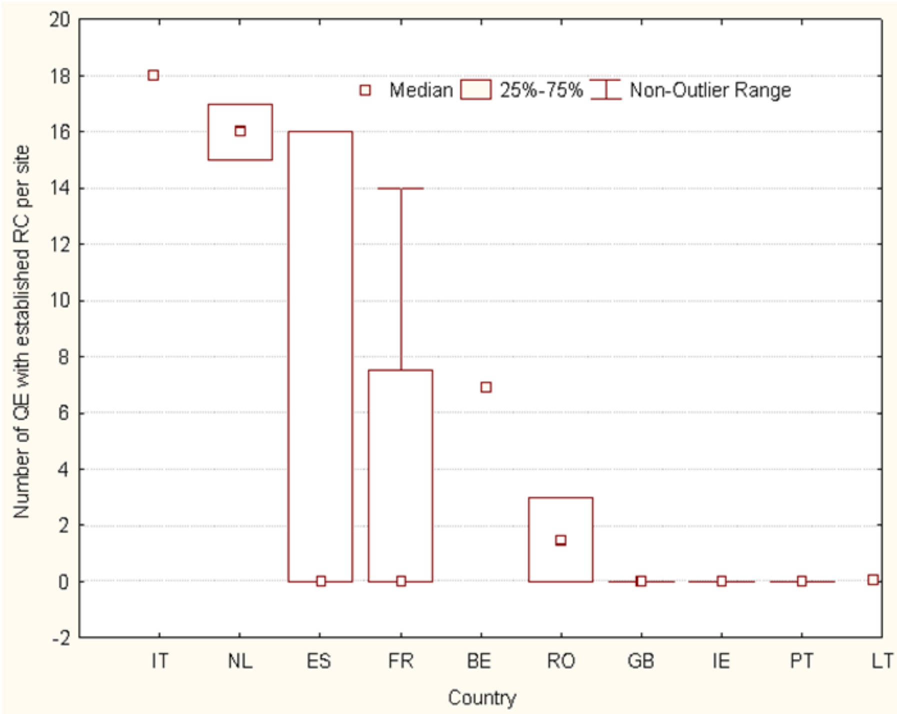


Fig. 4.7.3.9. Box and whiskers plot showing the ranges of reference conditions availability by countries for transitional waters included in the Final Intercalibration Register

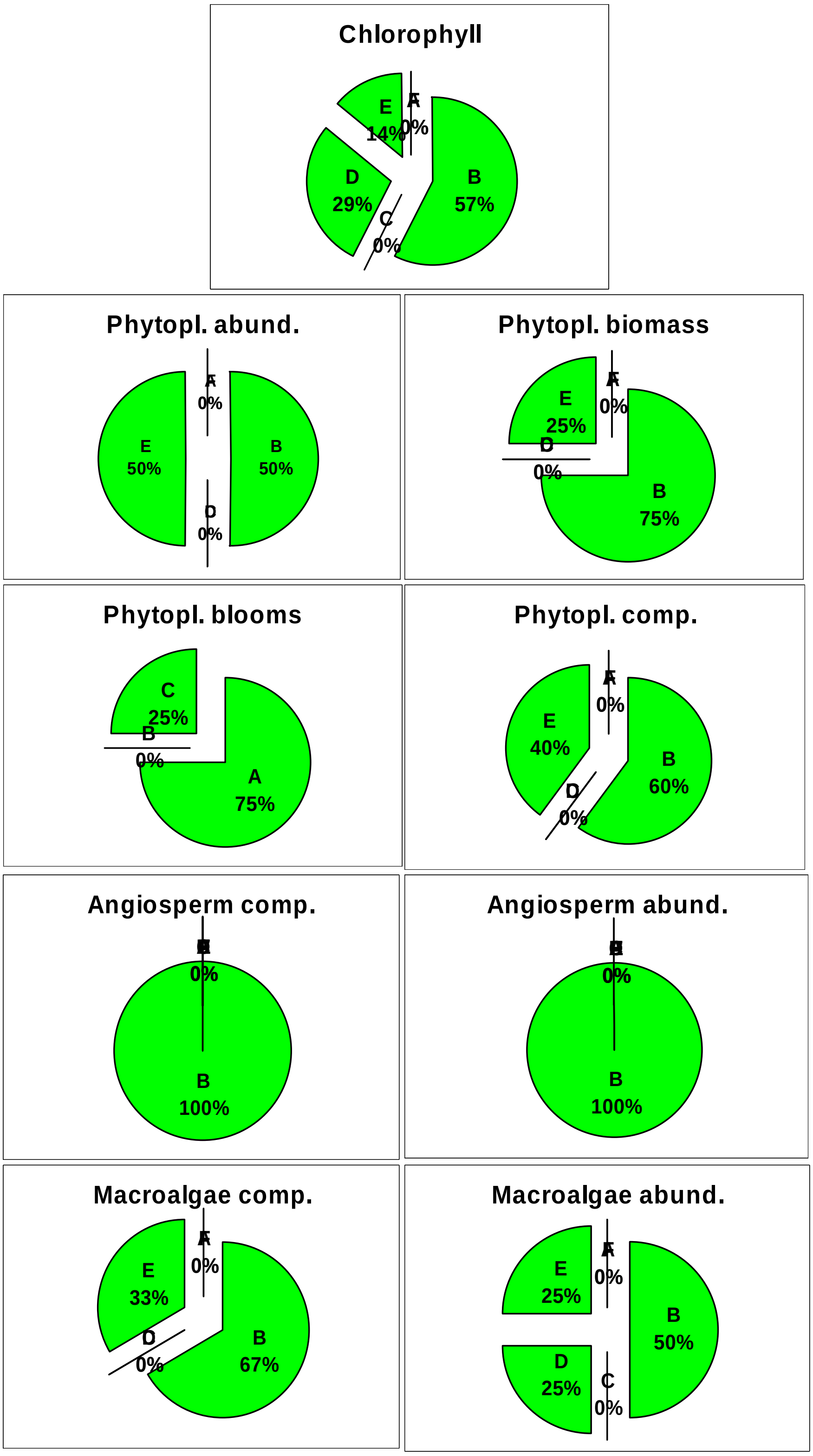


Fig. 4.7.3.10. Methods used to define reference conditions for quality elements of autotrophs in transitional waters. A – reference sites, B – historical data, C – paleo-biological methods, D - modelling, E – expert opinion.

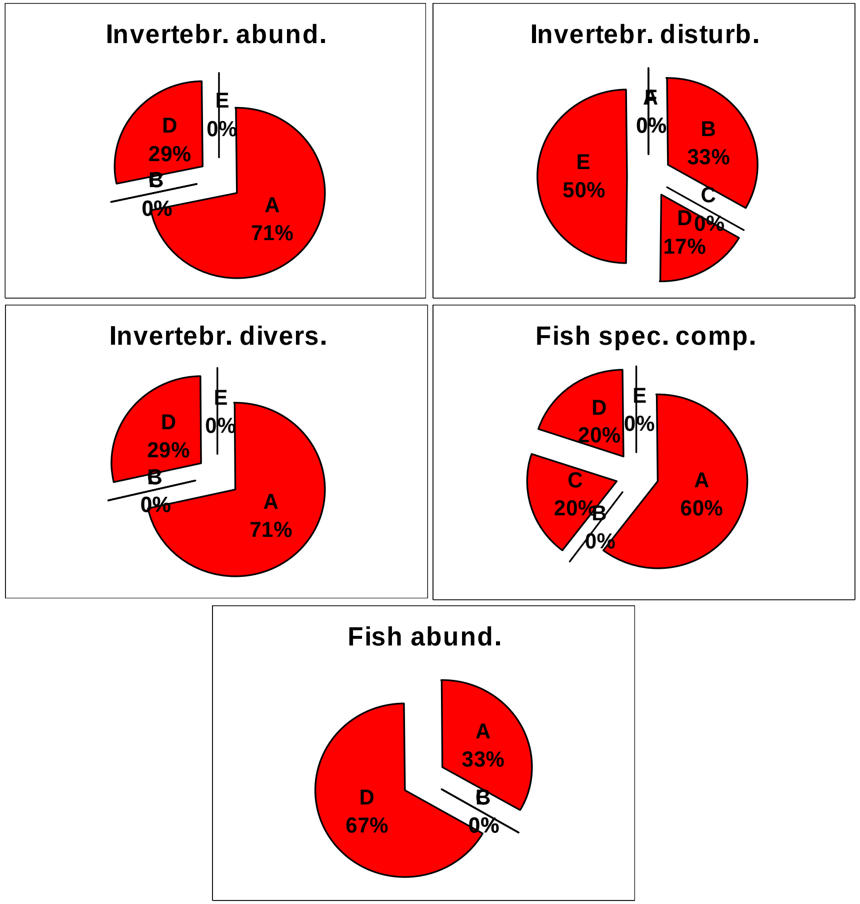


Fig. 4.7.3.11. Methods used to define reference conditions for quality elements of heterotrophs in transitional waters. A – reference sites, B – historical data, C – paleo-biological methods, D - modelling, E – expert opinion.

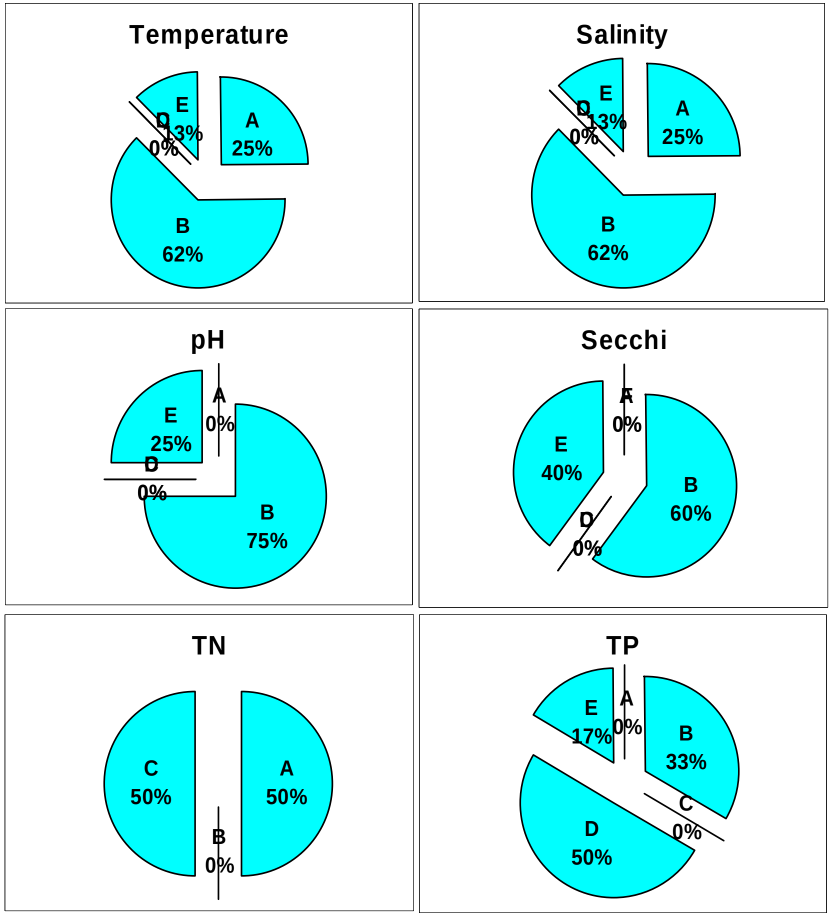


Fig. 4.7.3.12. Methods used to define reference conditions for physico-chemical quality elements in transitional waters. A – reference sites, B – historical data, C – paleo-biological methods, D - modelling, E – expert opinion.

- For autotrophic biological elements: *historical* data > *expert opinion* > *modelling* (reference sites, paleo-biological and curve fitting methods were not used)
- For heterotrophic biological elements: *historical data* > *expert opinion* > *modelling* (reference sites, paleo-biological and curve fitting methods were not used)

We mapped the availability of RC for total phosphorous, chlorophyll, invertebrate diversity and fish species composition at coastal sites (Appendix 3, XIII-XVI) and for total phosphorous, chlorophyll, phytobenthos composition and invertebrate diversity at transitional water sites (Appendix 3, XVII-XX).

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Medin, M., Ericsson, U., Nilsson, C., Sundberg, I. & Nilsson, P.-A., 2001. Bedömningsgrunder för bottenfaunaundersökningar. Medins Sjö- och Åbiologi AB. Mölnlycke, 12 pp.

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Appendix 1. Sites with outliers

Too small current velocity

COUNTRY	NAME	TYPE	Current velocity	Type criterium
DE	Amrum	CW-NEA1	<1 knot	1-3 knots
DE	Dithmarschen Bight	CW-NEA34	<1 knot	1-3 knots
DE	Eastern Ems	CW-NEA34	<1 knot	1-3 knots
DE	Trischen-Blauort	CW-NEA34	<1 knot	1-3 knots
DE	Western Ems	CW-NEA34	<1 knot	1-3 knots
DE	Hever	CW-NEA26	<1 knot	1-3 knots
DE	Spiekeroog Wadden Sea	CW-NEA26	<1 knot	1-3 knots
DE	Hoernum tidal basin	CW-NEA26	<1 knot	1-3 knots
DE	Wangerooge Open Sea	CW-NEA1	<1 knot	1-3 knots
DK	Danish Wadden Sea inner part	CW-NEA26	<1 knot	1-3 knots
DK	West Coast of Jutland - Hirtshals (1013)	CW-NEA1	<1 knot	1-3 knots
DK	Wadden Sea - Outer Part (DMU 1510008)	CW-NEA1	<1 knot	1-3 knots
FR	Pertuis Charentais	CW-NEA26	<1 knot	1-3 knots
FR	Merville-Franceville	CW-NEA1	<1 knot	1-3 knots
FR	Arcachon Amont	CW-NEA26	<1 knot	1-3 knots
FR	Concarneau large	CW-NEA1	<1 knot	1-3 knots
FR	Lorient Groix	CW-NEA1	<1 knot	1-3 knots
FR	Baie du Mont-Saint-Michel Ouest	CW-NEA26	<1 knot	1-3 knots
FR	Arcachon amont	CW-NEA26	<1 knot	1-3 knots
FR	Estuaire de l'Orne	TW-NEA11	<1 knot	1-3 knots
GB	Lough Foyle	CW-NEA26	<1 knot	1-3 knots
GB	Strangford Lough	CW-NEA26	<1 knot	1-3 knots
GB	Firth of Clyde	CW-NEA26	<1 knot	1-3 knots
GB	Cardigan Bay	CW-NEA1	<1 knot	1-3 knots
GB	Boulby Coast	CW-NEA1	<1 knot	1-3 knots
GB	Chichester Harbour	CW-NEA26	<1 knot	1-3 knots
GB	Conwy Bay	CW-NEA26	<1 knot	1-3 knots
GB	Essex Coast	CW-NEA1	<1 knot	1-3 knots
GB	Horden Coast	CW-NEA1	<1 knot	1-3 knots
GB	North Cornwall Coast	CW-NEA1	<1 knot	1-3 knots
GB	Northumberland-Berwickshire Coast	CW-NEA1	<1 knot	1-3 knots
GB	Tor Bay	CW-NEA26	<1 knot	1-3 knots
GB	Holy Island-Budle Bay	CW-NEA26	<1 knot	1-3 knots
GB	Cumbria Coast	CW-NEA1	<1 knot	1-3 knots
GB	St Bride's Bay	CW-NEA1	<1 knot	1-3 knots
GB	Foyle Estuary	TW-NEA11	<1 knot	1-3 knots
GB	Dart Estuary	TW-NEA11	<1 knot	1-3 knots
GB	Blackwater Estuary	TW-NEA11	<1 knot	1-3 knots
GB	Poole Harbour	TW-NEA11	<1 knot	1-3 knots
GB	Medway Estuary	TW-NEA11	<1 knot	1-3 knots
GB	Orwell-Stour Estuary	TW-NEA11	<1 knot	1-3 knots
GB	Tees Estuary	TW-NEA11	<1 knot	1-3 knots
GB	Cleddau Estuary	TW-NEA11	<1 knot	1-3 knots
GB	Tweed Estuary (lower)	TW-NEA11	<1 knot	1-3 knots
IE	Lough Foyle	CW-NEA26	<1 knot	1-3 knots
IE	Dublin Bay	CW-NEA1	<1 knot	1-3 knots
NO	Kvnangen	CW-NEA26	<1 knot	1-3 knots
NO	Troms	CW-NEA26	<1 knot	1-3 knots
NO	Trondheim Shallow	CW-NEA26	<1 knot	1-3 knots

Too high current velocity

COUNTRY	NAME	TYPE	Current velocity	Type criterium

IE	Wexford Harbour	CW-NEA26	>3 knots	1-3 knots
IE	Inner Clew Bay	CW-NEA1	>3 knots	1-3 knots
IE	Sligo Bay	CW-NEA26	>3 knots	1-3 knots
IE	Cork Harbour	CW-NEA26	>3 knots	1-3 knots
NO	Coast of Agder	CW-NEA10	1-3 knots	<1 knot
ES	CABO DE GATA	CW-M1	1-3 knots	<1 knot
IE	Westport Bay	CW-NEA26	>3 knots	1-3 knots
IE	Suir Estuary Lower	TW-NEA11	>3 knots	1-3 knots
ES	PUERTO DE ALMERIA	CW-M3	1-3 knots	<1 knot

Too sheltered

COUNTRY	NAME	TYPE	Exposure	Type criterium
FR	Chausey	CW-NEA1	mod. exp.	exposed
FR	Merville-Franceville	CW-NEA1	mod. exp.	exposed
FR	Etretat et Senneville	CW-NEA1	mod. exp.	exposed
FR	Cote de Nacre	CW-NEA1	mod. exp.	exposed
FR	Paimpol Perros-Guirrec	CW-NEA1	mod. exp.	exposed
GB	Northumberland-Berwickshire Coast	CW-NEA1	mod. exp.	exposed
IE	Inner Clew Bay	CW-NEA1	mod. exp.	exposed
IE	Outer Dundalk Bay	CW-NEA1	mod. exp.	exposed
NL	Waddenzee	CW-NEA34	sheltered	mod. exp.
PT	Ponte da Praia de Faro	CW-NEA26	very shelt.	sheltered
PT	Ramalhete	CW-NEA26	very shelt.	sheltered
ES	BARBATE	CW-NEA1	mod. exp.	exposed
SE	N Koevra	CW-NEA10	mod. exp.	exposed

Too exposed

COUNTRY	NAME	TYPE	Exposure	Type criterium
DE	Amrum	CW-NEA1	very exp.	exposed
DE	Trischen-Blauort	CW-NEA34	very exp.	exposed
DE	Hever	CW-NEA26	mod. exp.	sheltered
DE	Hoernum tidal basin	CW-NEA26	mod. exp.	sheltered
DE	Northern peninsula Darss-Zingst	CW-B12	exposed	sheltered
EE	Kiguste laht	CW-B12	mod. exp.	sheltered
ES	TRAFALGAR	CW-NEA1	very exp.	exposed
ES	Matxitxako-Getaria	CW-NEA26	mod. exp.	sheltered
ES	BAHIA DE EL CONFITAL	CW-NEA1	very exp.	exposed
ES	Tossa-Sant Feliu	CW-M2	very exp.	mod. exp.
ES	ARENYS-MATAR	CW-M3	exposed	mod. exp.
FI	Perameri	CW-B0	exposed	sheltered
FI	Bergoe	CW-B2	mod. exp.	sheltered
FI	Hailuoto	CW-B0	exposed	sheltered
FI	Bagaskar	CW-B3	mod. exp.	sheltered
FI	Langskar	CW-B3	very exp.	sheltered
FI	Domarkobban	CW-B3	exposed	sheltered
FR	Pertuis Charentais	CW-NEA26	exposed	sheltered
FR	Anse du Cul de Loup, Anse de Jonville	CW-NEA26	exposed	sheltered
FR	Baie de Bourgneuf	CW-NEA26	mod. exp.	sheltered
FR	Arcachon amont	CW-NEA26	mod. exp.	sheltered
GB	Lough Foyle	CW-NEA26	mod. exp.	sheltered
GB	Carlingford Lough	CW-NEA26	mod. exp.	sheltered
GB	Loch Ryan (site 1)	CW-NEA26	mod. exp.	sheltered
GB	Loch Ryan	CW-NEA26	mod. exp.	sheltered
GB	Stonehaven, Aberdeen	CW-NEA1	very exp.	exposed

GB	Loch Indaal	CW-NEA26	mod. exp.	sheltered
GB	Firth of Clyde - Kilbrannan Sound	CW-NEA7	mod. exp.	sheltered
GB	Busta Voe, Shetland	CW-NEA7	mod. exp.	sheltered
GB	Loch Torridon	CW-NEA7	mod. exp.	sheltered
GR	Saronikos Gulf	CW-M2	exposed	mod. exp.
GR	Thessaloniki gulf	CW-M3	exposed	mod. exp.
GR	S. Evvoikos gulf	CW-M2	very exp.	mod. exp.
IE	Lough Foyle	CW-NEA26	mod. exp.	sheltered
IE	Wexford Harbour	CW-NEA26	mod. exp.	sheltered
IE	Sligo Bay	CW-NEA26	mod. exp.	sheltered
IE	Cork Harbour	CW-NEA26	mod. exp.	sheltered
IE	Westport Bay	CW-NEA26	mod. exp.	sheltered
NO	Hammerfest	CW-NEA1	very exp.	exposed
NO	Nord-Mre	CW-NEA1	very exp.	exposed
NO	Bergen Inner Arc	CW-NEA26	mod. exp.	sheltered
PL	Mielizna Borzynska	CW-B14	mod. exp.	very shelt.
PL	Rowy	CW-B13	very exp.	exposed
PL	Kepa Redlowska	CW-B13	very exp.	exposed
PL	Piaski Dziewicze	CW-B14	sheltered	very shelt.
SE	The Koster fjord	CW-NEA10	very exp.	exposed
SE	The Gullmarn Fjord	CW-NEA9	mod. exp.	sheltered
SE	The Quark- Orefjarden	CW-B0	exposed	sheltered
SE	Lngvinds- and Skrsfjrden	CW-B2	mod. exp.	sheltered
SE	Archipelago of Torhamn	CW-B12	mod. exp.	sheltered
SE	The Askoe area (outer part of	CW-B3	mod. exp.	sheltered
SE	The Bay of Gavle, outer parts.	CW-B2	mod. exp.	sheltered
SE	SV Holmoearna, N Kvarken	CW-B0	mod. exp.	sheltered

Too strongly mixed

COUNTRY	NAME	TYPE	Mixing	Type criterium
NO	Coast of Lista	CW-NEA10	part. strat.	perm. strat.
ES	CABO DE GATA	CW-M1	fully mixed	part. strat.
FR	Estuaire de la Gironde	TW-NEA11	fully mixed	part. strat.
GB	Humber Estuary (Lower)	TW-NEA11	fully mixed	part. strat.
GB	Blackwater Estuary	TW-NEA11	fully mixed	part. strat.
GB	Montrose Basin	TW-NEA11	fully mixed	part. strat.
GB	Lower Forth Estuary	TW-NEA11	fully mixed	part. strat.
GB	Poole Harbour	TW-NEA11	fully mixed	part. strat.
GB	Medway Estuary	TW-NEA11	fully mixed	part. strat.
GB	Dee Estuary	TW-NEA11	fully mixed	part. strat.
GB	Orwell-Stour Estuary	TW-NEA11	fully mixed	part. strat.
GB	Thames Estuary	TW-NEA11	fully mixed	part. strat.
GB	Cleddau Estuary	TW-NEA11	fully mixed	part. strat.
NL	Westerschelde	TW-NEA11	fully mixed	part. strat.
NL	Eems-Dollard	TW-NEA11	fully mixed	part. strat.
ES	Bahia de Santander	TW-NEA11	fully mixed	part. strat.
ES	PUERTO DE ALMERIA	CW-M3	fully mixed	part. strat.

Too weakly mixed

COUNTRY	NAME	TYPE	Mixing	Type criterium
FR	Chausey	CW-NEA1	part. strat.	fully mixed
FR	Merville-Franceville	CW-NEA1	part. strat.	fully mixed
FR	Baie du Mont-Saint-Michel Sud	CW-NEA26	part. strat.	fully mixed
FR	Etretat et Senneville	CW-NEA1	part. strat.	fully mixed

FR	Cote de Nacre	CW-NEA1	part. strat.	fully mixed
FR	Baie de Bourgneuf	CW-NEA26	part. strat.	fully mixed
FR	Rade de Brest	CW-NEA26	part. strat.	fully mixed
FR	Lorient Groix	CW-NEA1	part. strat.	fully mixed
GB	Firth of Clyde	CW-NEA26	perm. strat.	fully mixed
GB	Sandsound Voe	CW-NEA26	part. strat.	fully mixed
GB	Firth of Clyde - Kilbrannan Sound	CW-NEA7	part. strat.	fully mixed
GB	Busta Voe, Shetland	CW-NEA7	part. strat.	fully mixed
GB	Loch Torridon	CW-NEA7	part. strat.	fully mixed
GB	Boulby Coast	CW-NEA1	part. strat.	fully mixed
GB	Horden Coast	CW-NEA1	part. strat.	fully mixed
GB	North Cornwall Coast	CW-NEA1	part. strat.	fully mixed
GB	Northumberland-Berwickshire Coast	CW-NEA1	part. strat.	fully mixed
GB	Holy Island-Budle Bay	CW-NEA26	part. strat.	fully mixed
IE	Wexford Harbour	CW-NEA26	part. strat.	fully mixed
IE	Sligo Bay	CW-NEA26	part. strat.	fully mixed
IE	Dublin Bay	CW-NEA1	part. strat.	fully mixed
IE	Malahide Bay	CW-NEA26	part. strat.	fully mixed
IE	Cork Harbour	CW-NEA26	part. strat.	fully mixed
NL	Hollandse kust	CW-NEA1	part. strat.	fully mixed
ES	Matxitxako-Getaria	CW-NEA26	part. strat.	fully mixed
IE	Westport Bay	CW-NEA26	part. strat.	fully mixed

Too long residence time

COUNTRY	NAME	TYPE	Resid. Time	Type criterium
DE	Amrum	CW-NEA1	weeks	days
DE	Dithmarschen Bight	CW-NEA34	weeks	days
DE	Eastern Ems	CW-NEA34	weeks	days
DE	Trischen-Blauort	CW-NEA34	weeks	days
DE	Western Ems	CW-NEA34	weeks	days
DE	Hever	CW-NEA26	weeks	days
DE	Spiekeroog Wadden Sea	CW-NEA26	weeks	days
DE	Hoernum tidal basin	CW-NEA26	weeks	days
DE	Wangerooge Open Sea	CW-NEA1	weeks	days
FR	Pertuis Charentais	CW-NEA26	weeks	days
FR	Baie du Mont-Saint-Michel Sud	CW-NEA26	weeks	days
FR	Etretat et Senneville	CW-NEA1	weeks	days
FR	Arcachon Amont	CW-NEA26	weeks	days
FR	Cote de Nacre	CW-NEA1	weeks	days
FR	Baie de Bourgneuf	CW-NEA26	weeks	days
FR	Golfe du Morbihan	CW-NEA26	months-years	days
FR	Concarneau large	CW-NEA1	months-years	days
FR	Paimpol Perros-Guirrec	CW-NEA1	weeks	days
FR	Rade de Brest	CW-NEA26	months-years	days
FR	Lorient Groix	CW-NEA1	weeks	days
FR	Baie du Mont-Saint-Michel Ouest	CW-NEA26	weeks	days
FR	Arcachon amont	CW-NEA26	weeks	days
GB	Lough Foyle	CW-NEA26	weeks	days
GB	Strangford Lough	CW-NEA26	weeks	days
GB	Carlingford Lough	CW-NEA26	weeks	days
GB	Loch Ryan (site 1)	CW-NEA26	weeks	days
GB	Loch Ryan	CW-NEA26	weeks	days
GB	Firth of Clyde	CW-NEA26	weeks	days
GB	Sandsound Voe	CW-NEA26	weeks	days
GB	Loch Indaal	CW-NEA26	weeks	days

Appendix 1. Sites with outliers

GB	Firth of Clyde - Kilbrannan Sound	CW-NEA7	months-years	days
GB	Busta Voe, Shetland	CW-NEA7	weeks	days
GB	Loch Torridon	CW-NEA7	weeks	days
GB	Thames Estuary	TW-NEA11	months-years	weeks
IE	Lough Foyle	CW-NEA26	weeks	days
IE	Wexford Harbour	CW-NEA26	weeks	days
IE	Inner Clew Bay	CW-NEA1	weeks	days
IE	Sligo Bay	CW-NEA26	weeks	days
IE	Dublin Bay	CW-NEA1	weeks	days
IE	Malahide Bay	CW-NEA26	weeks	days
IE	Cork Harbour	CW-NEA26	weeks	days
IE	Outer Dundalk Bay	CW-NEA1	weeks	days
IE	Westport Bay	CW-NEA26	weeks	days
NL	Hollandse kust	CW-NEA1	weeks	days
NL	Zeeuwse kust	CW-NEA1	weeks	days
NL	Waddenzee	CW-NEA34	weeks	days
SE	The Koster fjord	CW-NEA10	weeks	days
SE	The Gullmarn Fjord	CW-NEA9	months-years	weeks

Outliers regarding agreed type criteria

1. Rivers

Too small catchment

COUNTRY	NAME	TYPE	Catchment	Lower limit	Ratio
SK	Danube, Medvedov	R-E6	2724,87	131000	48,08
SK	Danube, Komarno	R-E6	2980,75	131000	43,95
SK	Cierna voda, Senec	R-E3	111,7	1000	8,95
GR	Tsouraki	R-M1	2	10	5,00
IT	Rio Capodacqua Santa	R-M5	2	10	5,00
ES	Ternelles-T3RF	R-M5	2,07	10	4,83
ES	Santome-SANTORF	R-C3	2,3	10	4,35
DE	Kleine Jahna	R-C4	24	100	4,17
ES	Larin-LARIRF	R-C2	2,4	10	4,17
SK	Maly Dunaj, Jelka	R-E3	267,6	1000	3,74
ES	Grande Xubia-GXU1AF	R-C2	3,2	10	3,13
DE	Tollense	R-C4	35	100	2,86
ES	Riotorto-RTOR	R-C2	3,6	10	2,78
IE	01M010100 Mourne Beg	R-N3	4	10	2,50
NO	Hotranvassdraget,	R-N2	4,1	10	2,44
RO	Ier - up. Unimat	R-E2	43	100	2,33
GB	Rothley Brook at Ratby	R-C4	48	100	2,08
GB	Ashgrove Tributary at	R-C2	5	10	2,00
GB	River Alaw at Llanfigael	R-C4	52	100	1,92
FR	4178130 - AULNE-STER	R-C2	6	10	1,67
FR	4154020 - PETIT LAY - st-	R-C2	6	10	1,67
GB	Glenroan Burn at Glenroan	R-C3	6	10	1,67
GR	SOURAKI SL98	R-M4	6	10	1,67
SK	Myjava, pod Myjavou	R-E4	67,4	100	1,48
FR	4171550 - TRIEUX - kerpert	R-C2	7	10	1,43
DE	Ohre	R-C5	700	1000	1,43
GB	Lisnabane Burn at	R-C6	7	10	1,43
GB	Killyglen Burn at Drains Bay	R-C6	7	10	1,43
GB	Tregeseal Stream at Carn	R-C2	7	10	1,43
GR	Onochonos-Smokovo	R-M1	7	10	1,43
IT	Fosso Ortolano	R-M5	7	10	1,43
GB	Tregeseal Stream at Carn	R-N2	7	10	1,43
ES	Francoli - Riba	R-M2	75	100	1,33
FR	4016855 - TERNIN -	R-C3	8	10	1,25
GB	Nant y Dernol at U/S Wye	R-C3	8	10	1,25
GB	Leys Farm Ditch at A4095	R-C6	8	10	1,25
GB	Hilton/Cut Throat Brook at	R-C6	8	10	1,25
NO	Kvernaani	R-N2	8	10	1,25
ES	Ternelles-T5RF	R-M5	8,07	10	1,24
ES	Fornalutx - Fornalutx	R-M5	8,2	10	1,22
RO	Rusavat	R-E2	82	100	1,22
FR	5237000 - NIVELLE -	R-C4	89	100	1,12
IT	Fiume Adda Localita	R-A2	9	10	1,11
DE	Neuludwigsdorf	R-C3	9	10	1,11
DE	Grosse Pyra	R-C3	9	10	1,11
ES	Valdebois-VALDRF	R-C2	9,4	10	1,06
DE	Rotbach	R-C1	9,5	10	1,05
ES	Onza-ONZARG	R-C2	9,5	10	1,05
ES	Eume-EUM1AG	R-C3	9,8	10	1,02
DE	Osterau	R-C4	99	100	1,01

Appendix 1. Sites with outliers

Too large catchment

COUNTRY	SITE NAME	TYPE	Catchment	Upper limit	Ratio
FR	6124900 - MIAN-SORGUE -	R-M1	1085	100	10,85
FR	6031200 - DOUBS - gevry	R-C4	5118	1000	5,12
FR	3178000-EPTE-fourges	R-C6	1353	300	4,51
ES	Trabaque - Priego	R-M1	408	100	4,08
FR	3265993 - AIROU - ver	R-C2	395	100	3,95
FR	6027000 - DOUBS -	R-A1	3464	1000	3,46
DE	Kremitz	R-C1	320	100	3,20
IT	Torrente Boite - Loc. Ponte di	R-M1	310	100	3,10
FR	6210400 - LOUP - cagnes	R-M1	257	100	2,57
FR	5226102 - ESTRIGON -	R-C1	256	100	2,56
FR	3068950 - JUINE - st-vrain	R-C6	729	300	2,43
EE	Porijgi	R-C1	241	100	2,41
FR	6021000 - DOUBS - mathay	R-A1	2381	1000	2,38
FR	6204500 - ISSOLE - cabasse	R-M1	231	100	2,31
FR	3089000 - MARNE - marnavl	R-C4	2258	1000	2,26
FR	3265600 - SIENNE - la	R-C2	218	100	2,18
FR	6010000 - OGNON - pesmes	R-C4	2025	1000	2,03
FR	6204000 - CARAMY - vins	R-M1	202	100	2,02
DE	Pulsnitz	R-C1	200	100	2,00
ES	Mazarron - Mazarron	R-M5	200	100	2,00
FI	Simojoki	R-N3	1981	1000	1,98
FR	6127000 - GARDON D ALES	R-M1	181	100	1,81
AT	Deutsche Thaya, near	R-C3	175	100	1,75
FR	05190007-CORREZE-	R-C3	173	100	1,73
FR	5139310 - GIJOU - rocalet	R-C3	166	100	1,66
FR	6175300 - BERRE 11 -	R-M1	159	100	1,59
AT	Grosse Ysper, above	R-C3	158	100	1,58
EE	Jagala	R-C4	1572	1000	1,57
FR	5042080 - AUVEZERE -	R-C3	156	100	1,56
ES	Bunol - Alboracke	R-M1	155	100	1,55
FR	5215100 - GAVE DE PAU -	R-C4	1535	1000	1,54
FR	6177000 - AUDE - pomas	R-C4	1522	1000	1,52
NL	Oude Graaf Hugten	R-C1	150	100	1,50
NL	Gasterensche Diep	R-C1	150	100	1,50
NO	Rinda, OPPERIN1	R-N1	150	100	1,50
FR	6033000 - LOUE - parcey	R-C4	1483	1000	1,48
LU	Clerve, aval step Clervaux	R-C1	144	100	1,44
FR	6039900 - GROSNE - st	R-C3	141	100	1,41
FR	3057985 - FUSAIN - chteau-	R-C6	421	300	1,40
NL	Niers Zelderheide	R-C4	1400	1000	1,40
FR	6071900 - FIER - motz	R-A1	1373	1000	1,37
PT	III-S-1	R-M5	136	100	1,36
FR	6013800 - TILLE - champdtre	R-C4	1352	1000	1,35
CZ	Dyje confluence with Morava	R-C5	13426	10000	1,34
FR	4172570 - GUINDY -	R-C2	128	100	1,28
FR	1101000 - AA - wizernes	R-C6	378	300	1,26
FR	5057150 - VEZERE - bugeat	R-C3	125	100	1,25
ES	Martin - Arino	R-M2	1227	1000	1,23
DE	Olbitzbach	R-C1	122	100	1,22
RO	Tarnava Mica	R-E1	1213	1000	1,21
DE	Hochspeyerbach	R-C3	119	100	1,19
FR	5204000 - GAVE D	R-C4	1170	1000	1,17
FR	3213000 - VARENNE -	R-C6	346	300	1,15
FR	05651002-Gave de Pau-	R-A2	1152	1000	1,15

BE	Houille	R-C3	114	100	1,14
FR	5033500 - DRONNE - pont	R-C4	1139	1000	1,14
FR	5038000 - ISLE - pont de la	R-C4	1139	1000	1,14
FR	3052785 - BEZONDE -	R-C6	340	300	1,13
FR	6156000 - BUECH -	R-M4	1132	1000	1,13
IE	30C010100 Clare (Galway)	R-C6	335	300	1,12
FR	6176000 - AUDE - luc sur	R-C4	1087	1000	1,09
FR	6211000 - VAR -	R-M4	1079	1000	1,08
FR	3175000 - EPTE -	R-C6	321	300	1,07
PL	Ugoszcz	R-C1	107	100	1,07
FR	3014780 - AUBE -	R-C6	316	300	1,05
FR	3187000 - EURE - st-luperce	R-C6	312	300	1,04
FR	5192051 - R. DES FORGES -	R-C1	104	100	1,04
FR	3097000 - SAULX - stainville	R-C6	311	300	1,04
DE	Hafenlohr	R-C3	103	100	1,03
DE	Luppa	R-C2	102	100	1,02
FR	6084300 - AIN - pont de	R-A1	1018	1000	1,02
FR	3116720 - GRAND MORIN -	R-C6	305	300	1,02
DE	Dreibach	R-C1	101	100	1,01

Too low altitude

COUNTRY	NAME	TYPE	ALT	Lower limit	Ratio
FR	6210400 - LOUP - cagnes	R-M1	10	200	20,0
FR	6124900 - MIAN-SORGUE -	R-M1	26	200	7,7
IT	Fiume Mignone - Loc.	R-M4	125	400	3,2
IT	Fiume Mignone	R-M4	126	400	3,2
RO	Nadrag	R-E1	210	500	2,4
FR	6175300 - BERRE 11 -	R-M1	87	200	2,3
ES	Muga - Boadella	R-M1	95	200	2,1
DE	Duennbach	R-C3	100	200	2,0
FR	05651002-Gave de Pau-	R-A2	322	500	1,6
RO	Tarnava Mica	R-E1	330	500	1,5
FR	6071900 - FIER - motz	R-A1	268	400	1,5
SK	Rajcanka, Zilina	R-E1	337	500	1,5
FR	6211000 - VAR -	R-M4	273	400	1,5
SK	Myjava, pod Myjavou	R-E4	137	200	1,5
FR	6069050 - USSES - seyssel	R-A1	283	400	1,4
FR	6210900 - TINEE - tournefort	R-M4	284	400	1,4
IT	Torrente Farfa	R-M4	288	400	1,4
FR	6027000 - DOUBS -	R-A1	301	400	1,3
SK	Varinka, Varin	R-E1	384	500	1,3
FR	01590040-Solre-Solrinnes	R-C3	155	200	1,3
SK	Myjava, Kuty	R-E4	157	200	1,3
FR	6127000 - GARDON D ALES	R-M1	159	200	1,3
DE	Klingbach below Hausen	R-C3	160	200	1,3
FR	6021000 - DOUBS - mathay	R-A1	335	400	1,2
NO	Trylandvassdraget v/Barstoel	R-N5	170	200	1,2
NO	Dybingsvatnet, utloep	R-N5	176	200	1,1
FR	6175600 - AUDE - axat	R-A2	447	500	1,1
DE	Hochspeyerbach	R-C3	180	200	1,1
NO	Logaana-Laudal	R-N5	180	200	1,1
FR	6071000 - CHERAN - rumilly	R-A1	366	400	1,1
FR	6085500 - BIENNE - jeurre	R-A1	369	400	1,1
AT	Rabnitz, near Lutzmannsburg	R-E4	190	200	1,1
DE	Erlbach	R-C3	190	200	1,1
AT	Wildbach, near Kramermirtl	R-A2	477	500	1,0
SI	SAVA OTOCE	R-A1	387	400	1,0

NO	Fosstoelbekken	R-N5	195	200	1,0
AT	Weisse Sulm, Sulmklamm	R-A2	491	500	1,0
FR	05311001-PIQUE- CIERP-	R-A2	496	500	1,0

Too high altitude

COUNTRY	NAME	TYPE	ALT	Upper limit	Ratio
FR	2048950-MOSELLE-fresse	R-C6	522	200	2,6
NO	Vismunda, OPPEVIS1	R-N4	500	200	2,5
FR	2065200-PLAINE-allarmont	R-C6	390	200	2,0
FR	3014130 - AUBE - auberive	R-C6	355	200	1,8
FR	3036350 - ARMANCON -	R-C6	350	200	1,8
ES	Esera - Benasque	R-A2	1733	1000	1,7
RO	Ier - up. Unimat	R-E2	345	200	1,7
LU	Clerve, aval step Clervaux	R-C1	342	200	1,7
DE	Werra	R-C4	335	200	1,7
ES	Caldes - Gallifa	R-M5	500	300	1,7
FR	2106660 - MOUZON -	R-C6	326	200	1,6
IT	Torrente Boite - Loc.	R-A1	1295	800	1,6
FR	2054300-DURBION-	R-C6	314	200	1,6
ES	Gallego - Formigal	R-A2	1532	1000	1,5
ES	Segre - Llivia	R-A2	1532	1000	1,5
FR	3039240 - BRENNE -	R-C6	300	200	1,5
FR	04150002-COURBIERES-	R-C3	1190	800	1,5
FR	3006272 - OURCE - recey	R-C6	290	200	1,5
IT	Torrente Sarca di Campiglio	R-A1	1149	800	1,4
FR	05651001-Gave de Pau-	R-A2	1370	1000	1,4
IT	Torrente Boite - Loc. Scolo	R-A1	1095	800	1,4
FR	3021355 - AUJON - cour l	R-C6	262	200	1,3
IT	Fiume Adda Localita le	R-A2	1301	1000	1,3
FR	06050048-DRAC BLANC-	R-A2	1290	1000	1,3
LU	Clerve, Kautenbach	R-C6	257	200	1,3
AT	Winklbach, near	R-A2	1280	1000	1,3
IT	Fiume Trino - Piana dei	R-M3	768	600	1,3
FR	05311004-VOLP-au PLAN	R-C4	252	200	1,3
FR	6003950 - SALON - coublanc	R-C4	250	200	1,3
LU	Attert, aval Everlange	R-C6	250	200	1,3
FR	2107900 - MEHOLLE - void	R-C6	249	200	1,2
FR	03210050-Seine-Nod	R-C4	248	200	1,2
FR	03520034-Marne-Condes	R-C4	248	200	1,2
FR	3014780 - AUBE -	R-C6	247	200	1,2
IT	Fiume Sangro - Sterparo	R-M3	740	600	1,2
IT	Torrente Cordevole	R-A1	980	800	1,2
AT	Isar, near Scharnitz	R-A1	979	800	1,2
FR	6176000 - AUDE - luc sur	R-C4	240	200	1,2
IT	Torrente Noce - Pejo	R-A2	1191	1000	1,2
FR	4028400 - ALAGNON -	R-C3	940	800	1,2
FR	6001180 - PETITE AMANCE	R-C6	235	200	1,2
IT	Fiume Oglio Ponte Salto del	R-A1	937	800	1,2
ES	Pastrana - Ugejar	R-M5	350	300	1,2
ES	Carcabo - Cieza	R-M5	350	300	1,2
ES	Noguera Pallaresa - Isil	R-A2	1165	1000	1,2
FR	6150500 - DURANCE -	R-A2	1164	1000	1,2
FR	6150800 - GUIL - mont-	R-A2	1150	1000	1,2
DE	Helbe	R-C4	230	200	1,2
FR	2104900 - ROTTE - vatimont	R-C6	228	200	1,1
IT	Torrente Padola	R-A1	910	800	1,1
IT	Rio Val di Stava	R-A1	900	800	1,1

IT	Fiume Tagliamento Forni di	R-A1	900	800	1,1
FR	3040490 - BRENNE - seigny	R-C4	225	200	1,1
IT	Torrente Boite - Loc. Ponte di	R-M1	900	800	1,1
ES	Resinero - Toro	R-M1	900	800	1,1
FR	06050041-GYRONDE-	R-A2	1120	1000	1,1
IT	Roggia di Fondo	R-A1	891	800	1,1
FR	6152000 - UBAYE - st-pons	R-A2	1108	1000	1,1
FR	4171550 - TRIEUX - kerpert	R-C2	218	200	1,1
FR	4178130 - AULNE-STER	R-C2	217	200	1,1
IT	Fosso Ortolano	R-M5	325	300	1,1
IT	Rio Val di Gambis	R-A1	849	800	1,1
AT	Mur, Maander	R-A2	1060	1000	1,1
FR	5215100 - GAVE DE PAU -	R-C4	211	200	1,1
IT	Torrente Mae	R-A1	837	800	1,0
AT	Taurach	R-A2	1045	1000	1,0
FR	2105000 - NIED-	R-C4	209	200	1,0
AT	Salza, near Mariazell	R-A1	830	800	1,0
IT	Torrente Ansiei	R-A1	830	800	1,0
ES	Barrosa - Parzan	R-A2	1037	1000	1,0
HU	Pinka, Vasalja	R-E2	205	200	1,0
HU	Kerka River, Magyarfoeld	R-E2	204	200	1,0
LU	Attert, Comar-Berg	R-C6	204	200	1,0
IT	Fosso della Mola	R-M5	305	300	1,0
FR	3097000 - SAULX - stainville	R-C6	202	200	1,0
AT	Gail, Wodmaier Brucke	R-A1	807	800	1,0
IT	Torrente Biois	R-A1	805	800	1,0
ES	Noguera Cardos - Lladorre	R-A2	1006	1000	1,0
HU	Repce, Vasegerszeg	R-E2	201	200	1,0

Too narrow rivers

COUNTRY	NAME	TYPE	Bankfull size	Lower limit	Ratio
DE	Hunte	R-C5	1	25	25,0
DE	Kleine Jahna	R-C4	1	8	8,0
DK	Stenderup Baek, near	R-C1	1	3	3,0
FR	4178130 - AULNE-STER	R-C2	1	3	3,0
FR	4154020 - PETIT LAY - st-	R-C2	1	3	3,0
DE	Plane	R-C1	1	3	3,0
DE	Lutzke	R-C1	1	3	3,0
DE	Dreibach	R-C1	1	3	3,0
DE	Belziger Bach	R-C1	1	3	3,0
DE	Dahle	R-C2	1	3	3,0
GB	Hilton/Cut Throat Brook at	R-C6	1	3	3,0
BE	Grote Nete 1	R-C4	4	8	2,0
GB	Rothley Brook at Ratby	R-C4	4	8	2,0
ES	Riotorto-RTOR	R-C2	1,5	3	2,0
GB	River Alaw at Llanfigael	R-C4	4,2	8	1,9
DE	Schwarze Elster	R-C5	15	25	1,7
DE	Ohre	R-C5	15	25	1,7
FR	05821008-LEMBOULAS-a	R-C4	5	8	1,6
DE	Spree	R-C4	5	8	1,6
LT	Veivirzas at Veivirzenai	R-C4	5	8	1,6
BE	IJsse	R-C1	2	3	1,5
BE	Warmbeek 2	R-C1	2	3	1,5
DK	Skaerbaek, near Valborg hus	R-C1	2	3	1,5
DK	Vibaek, Vibaek bro	R-C1	2	3	1,5
FR	4171550 - TRIEUX - kerpert	R-C2	2	3	1,5
DE	Albrechtsbach	R-C2	2	3	1,5

GB	Lisnabane Burn at	R-C6	2	3	1,5
GB	Ashgrove Tributary at	R-C2	2	3	1,5
GB	Killyglen Burn at Drains Bay	R-C6	2	3	1,5
GB	Leys Farm Ditch at A4095	R-C6	2	3	1,5
GB	Tregeseal Stream at Carn	R-C2	2	3	1,5
LT	Geluza above Valkininkai	R-C1	2	3	1,5
SE	River A fran Limmaren	R-C1	2	3	1,5
LT	Sesuvis at Skirgailiai	R-C5	17	25	1,5
BE	Laan	R-C4	6	8	1,3
BE	Kleine Nete 1	R-C4	6	8	1,3
FR	02550042-ORNE-	R-C4	6	8	1,3
DE	Osterau	R-C4	6	8	1,3
IE	26I011350 Inny Shrule Br	R-C5	20	25	1,3
PL	Gizela	R-C1	2,5	3	1,2
ES	Onza-ONZARG	R-C2	2,5	3	1,2
ES	Rego Xallas-REGXRF	R-C2	2,5	3	1,2
ES	Grande Xubia-GXU1AF	R-C2	2,5	3	1,2
BE	Berwijn	R-C4	7	8	1,1
FR	3047680 - ECOLE - pringy	R-C4	7	8	1,1
DE	Eltingmuehlenbach near	R-C4	7	8	1,1
DE	Oertze N of Poitzen	R-C4	7	8	1,1
LT	Bartuva above Skuodas	R-C4	7	8	1,1
NL	Swalm Hoosterhof	R-C4	7	8	1,1
NL	Worm Haanrade	R-C4	7	8	1,1
FR	05471002-BAISE- VIANNE	R-C5	22	25	1,1
BE	Honnelle	R-C1	2,7	3	1,1
FR	04720011-HUISNE-Avze	R-C5	23	25	1,1
LT	Minija below Gargzdai	R-C5	24	25	1,0
LT	Zeimena below Svencioneliai	R-C5	24,5	25	1,0

Too wide rivers

COUNTRY	NAME	TYPE	Bankfull size	Upper limit	Ratio
FR	1092000 - LIANE -	R-C6	52	10	5,2
FR	6031200 - DOUBS - gevry	R-C4	80	25	3,2
FR	3265600 - SIENNE - la	R-C2	25	8	3,1
EE	Jagala	R-C4	60	25	2,4
EE	Vhandu - lemjooks	R-C4	60	25	2,4
EE	Vhandu - Kirupe	R-C4	60	25	2,4
FR	5204000 - GAVE D	R-C4	60	25	2,4
FR	6033000 - LOUE - parcey	R-C4	55	25	2,2
FR	3187000 - EURE - st-luperce	R-C6	20	10	2,0
FR	5139310 - GIJOU - rocalet	R-C3	20	10	2,0
GB	River Calder at d/s	R-C2	15	8	1,9
GB	River Bervie at u/s Macphies	R-C2	13	8	1,6
FR	6041800 - SEILLE - st-usuge	R-C4	40	25	1,6
FR	5215100 - GAVE DE PAU -	R-C4	40	25	1,6
FR	5038000 - ISLE - pont de la	R-C4	40	25	1,6
FR	6010000 - OGNON - pesmes	R-C4	40	25	1,6
IE	34M020700 Moy Ballylahan	R-C4	40	25	1,6
FR	3039240 - BRENNE -	R-C6	15	10	1,5
FR	3034510 - SEREIN - bierre	R-C3	15	10	1,5
FR	3057985 - FUSAIN - chteau-	R-C6	15	10	1,5
DE	Grosse Vils	R-C3	15	10	1,5
IE	30C010100 Clare (Galway)	R-C6	15	10	1,5
PL	Lega	R-C1	12	8	1,5
GB	Glendun River at	R-C3	14	10	1,4
GB	Endrick Water at Drymen	R-C4	35	25	1,4

FR	05190007-CORREZE-	R-C3	13	10	1,3
FR	3178000-EPTE-fourges	R-C6	13	10	1,3
GB	Allt Eigheach at road bridge	R-C3	13	10	1,3
GB	Craufurdland Water At	R-C2	10	8	1,3
FR	6039900 - GROSNE - st	R-C3	12	10	1,2
FR	1101000 - AA - wizernes	R-C6	12	10	1,2
FR	2104900 - ROTTE - vatimont	R-C6	12	10	1,2
FR	3052785 - BEZONDE -	R-C6	12	10	1,2
FR	4172570 - GUINDY -	R-C2	9	8	1,1
FR	5226102 - ESTRIGON -	R-C1	9	8	1,1
LT	Buka above Baluosas	R-C1	9	8	1,1
ES	Hoyamala-NAN006	R-C2	9	8	1,1
FR	05121002-BORALDE DE	R-C3	11	10	1,1

Too low alkalinity

COUNTRY	NAME	TYPE	ALK	Lower limit	Ratio
DE	Verlorenwasserbach	R-C1	0,05	0,4	8,0
GB	Allan water at NN817066	R-C4	0,1	0,4	4,0
LU	Clerve, Kautenbach	R-C6	0,7	2	2,9
DK	Mattrup aa, downstream	R-C6	1,4	2	1,4

Too high alkalinity

COUNTRY	NAME	TYPE	ALK	Upper limit	Ratio
CZ	Velicka Suchovske Mlyny	R-C3	4,4	0,4	11,0
IE	12D030200 Douglas (Ballon)	R-C2	2,1	0,4	5,3
ES	Marin-BI003	R-C3	2	0,4	5,0
IE	11O010500 Owenavorragh	R-C2	1,6	0,4	4,0
ES	Ricabo-NAL052	R-C3	1,5	0,4	3,8
DE	Kalltalsperre	R-C3	1,3	0,4	3,3
DE	Linneperhutte	R-C3	1,3	0,4	3,3
DE	Neuludwigsdorf	R-C3	1,3	0,4	3,3
AT	Aschauer (Reither) Ache,	R-A2	2,8	1	2,8
ES	Hoyamala-NAN006	R-C2	1,1	0,4	2,8
AT	Rauriser Ache	R-A2	2,5	1	2,5
ES	Genestaza-NAL043	R-C3	1	0,4	2,5
DE	Oberprether Muhle	R-C3	0,9	0,4	2,3
GB	Craufurdland Water At	R-C2	0,9	0,4	2,3
AT	Taurach	R-A2	2,1	1	2,1
ES	Cinca - Salinas	R-A2	2	1	2,0
ES	Cinqueta - Salinas	R-A2	2	1	2,0
GB	Ashgrove Tributary at	R-C2	0,8	0,4	2,0
GB	Glendun River at	R-C3	0,8	0,4	2,0
GB	Avon Water at Gordleton	R-C2	0,8	0,4	2,0
ES	Vellos - Macimiento	R-A2	1,9	1	1,9
IE	25N020100 Newport (Tipp.)	R-N1	1,9	1	1,9
AT	Deutsche Thaya, near	R-C3	0,7	0,4	1,8
GB	Glensawisk Burn at	R-C3	0,7	0,4	1,8
GB	Fenwick Water at Assloss	R-C2	0,7	0,4	1,8
GB	Hepste at D/S Two Bridges	R-C3	0,7	0,4	1,8
ES	Noguera Pallaresa - Isil	R-A2	1,5	1	1,5
ES	Esera - Castejon	R-A2	1,5	1	1,5
NO	Lena, OPPELEN1	R-N4	1,5	1	1,5
NO	Rinda, OPPERIN1	R-N1	1,5	1	1,5
GB	Glenroan Burn at Glenroan	R-C3	0,6	0,4	1,5
GB	Loughermore River at	R-C3	0,6	0,4	1,5
FI	Vanjoki 24,2	R-N3	0,3	0,2	1,5

FI	Kiskonjoki	R-N3	0,3	0,2	1,5
GB	Cothi at Moelfre	R-N2	0,3	0,2	1,5
GB	Annas at 5m D.S. Bridge at	R-N2	0,3	0,2	1,5
GB	Tregeseal Stream at Carn	R-N2	0,3	0,2	1,5
ES	Gallego - Formigal	R-A2	1,4	1	1,4
ES	Segre - Llivia	R-A2	1,3	1	1,3
ES	Barrosa - Parzan	R-A2	1,3	1	1,3
FI	Isojoki, Villamo vp 16100	R-N3	0,26	0,2	1,3
AT	Sarmingbach, Wolfsschlucht	R-C3	0,5	0,4	1,3
DE	Hochspeyerbach	R-C3	0,5	0,4	1,3
GB	River Bervie at u/s Macphies	R-C2	0,5	0,4	1,3
ES	Noguera Pallaresa - Llavorsi	R-A2	1,2	1	1,2

Too high colour

COUNTRY	NAME	TYPE	COLOR	Upper limit	Ratio
NO	Lena, OPPELEN1	R-N4	35	30	1,2
NO	Vismunda, OPPEVIS1	R-N4	32	30	1,1

2. Lakes

Too small lakes

COUNTRY	NAME	TYPE	AREA	Lower limit	Ratio
NO	Tjoernstoeltjoern, NVE	L-N5	0,1	0,5	5,0
RO	Dopca Reservoir	L-M7	0,11	0,5	4,5
NO	Nedre Furuvatn, NVE	L-N6	0,12	0,5	4,2
NO	Tussetjoern, NVE nr.1311	L-N5	0,14	0,5	3,6
NO	Rognstoeylsvatn, NVE-31858	L-N5	0,19	0,5	2,6
NO	Drivenesvatnet, NVE nr.	L-N3	0,2	0,5	2,5
RO	Valea de Pesti Reservoir	L-M7	0,22	0,5	2,3
NO	Markusdalsvatnet, NVE-	L-N5	0,25	0,5	2,0
NO	Langtjernet, NVE-7272	L-N6	0,25	0,5	2,0
NO	Sognevatnet, NVE-11078	L-N6	0,27	0,5	1,9
NO	Indre Espelandsvatnet, NVE-	L-N6	0,3	0,5	1,7
NO	Holmevatn, NVE-29741	L-N5	0,34	0,5	1,5
NO	Oeyvannet, NVE-5742	L-N6	0,37	0,5	1,4
IT	LAGO DI SEGRINO	L-AL4	0,4	0,5	1,3
IE	Lough Moher	L-N1	0,4	0,5	1,3
NO	Kleivsetvatnet, NVE nr.	L-N3	0,4	0,5	1,3
SE	Lake Orvattnet	L-N5	0,4	0,5	1,3
NO	Skardvatnet, NVE-36436	L-N5	0,49	0,5	1,0

Too large lakes

COUNTRY	NAME	TYPE	AREA	Upper limit	Ratio
IE	Ballynakill	L-A3	0,6	0,5	1,2

Too high altitude lakes

COUNTRY	NAME	TYPE	ALT	Upper limit	Ratio
ES	PORTODEMOUROS	L-M5	252	200	1,3
ES	YEGUAS	L-M5	249	200	1,2
PL	Wizajny	L-CE2	242	200	1,2
AT	Weissensee	L-AL3	929	800	1,2
FR	Petichet	L-AL3	923	800	1,2
ES	SAN ESTEBAN	L-M5	229	200	1,1
FR	Laffrey	L-AL3	908	800	1,1

ES	SALIME	L-M5	223	200	1,1
ES	PALMACES	L-M8	885	800	1,1
FR	Saint-Point	L-AL3	850	800	1,1
ES	GUADALMELLATO	L-M5	211	200	1,1
ES	VALPARAISO	L-M7	833	800	1,0
RO	Vidraru Reservoir	L-M7	830	800	1,0
RO	Valea de Pesti Reservoir	L-M7	826	800	1,0
DE	Alpsee bei Fuessen	L-AL3	814	800	1,0

Too shallow lakes

COUNTRY	NAME	TYPE	Mean depth	Lower limit	Ratio
GB	Hornsea Mere	L-A2	1,5	3	2,0
RO	Bezid Reservoir	L-M7	8	15	1,9
RO	Dopca Reservoir	L-M7	8,5	15	1,8
IE	Lower MacNean	L-A2	1,7	3	1,8
FR	Petichet	L-AL3	10	15	1,5
PT	Monte da Rocha	L-M5	10	15	1,5
PT	Montargil	L-M5	10	15	1,5
RO	Sacele Reservoir	L-M7	10	15	1,5
ES	AGAVANZAL	L-M7	10	15	1,5
FI	Joutsijarvi	L-N3	2	3	1,5
GB	Lower MacNean	L-A2	2	3	1,5
IE	Lough Bunny	L-A2	2	3	1,5
PT	Maranhao	L-M5	11	15	1,4
ES	PALMACES	L-M8	11	15	1,4
PT	Fronhas	L-M5	12	15	1,3
GB	Loch Lomond South Basin	L-N2b	12	15	1,3
DE	Grosser Alpsee bei	L-AL3	13	15	1,2
ES	AGUEDA	L-M7	13	15	1,2
ES	VALPARAISO	L-M7	14	15	1,1
IE	Lough O'Flynn	L-A2	2,9	3	1,0

Too deep lakes

COUNTRY	NAME	TYPE	Mean depth	Upper limit	Ratio
DK	Soeholm Soe	L-CE2	6,5	3	2,2
DK	Bryrup Langsoe	L-CE2	4,6	3	1,5
DE	Grimnitzsee	L-CE2	4	3	1,3
PL	Kolowin Lake	L-CE2	4	3	1,3
DK	Maglesoe	L-CE2	3,6	3	1,2
DK	Nors Soe	L-CE2	3,6	3	1,2
NL	Zegerplas	L-CE1	18	15	1,2
DK	Bastrup Soe	L-CE2	3,5	3	1,2
AT	Mattsee	L-AL4	17	15	1,1
AT	Obertrumer See	L-AL4	17	15	1,1

Too low alkalinity lakes

COUNTRY	NAME	TYPE	ALK	Lower limit	Ratio
EE	Ihamaru Palojarv	L-CE3	0,06	0,2	3,3
EE	Nohipalu Valgjarv	L-CE3	0,1	0,2	2,0
IT	LAGO DI MEZZOLA	L-AL3	0,7	1	1,4
GB	Upper MacNean	L-A2	0,7	1	1,4
GB	Lattone	L-A1	0,86	1	1,2
IE	Lattone	L-A1	0,86	1	1,2

Too high alkalinity lakes

Appendix 1. Sites with outliers

COUNTRY	NAME	TYPE	ALK	Upper limit	Ratio
RO	Vidraru Reservoir	L-M7	4,91	1	4,9
IT	BACINO DELL ALTO	L-M7	4	1	4,0
RO	Paltinu Reservoir	L-M7	3,8	1	3,8
RO	Dopca Reservoir	L-M7	3,75	1	3,8
RO	Bezid Reservoir	L-M7	3,7	1	3,7
RO	Maneciu Reservoir	L-M7	3,7	1	3,7
RO	Sacele Reservoir	L-M7	3,36	1	3,4
RO	Siriu Reservoir	L-M7	2,3	1	2,3
RO	Izvorul Muntelui Reservoir	L-M7	2	1	2,0
RO	Bradisor Reservoir	L-M7	1,98	1	2,0
ES	GUADALMELLATO	L-M5	1,7	1	1,7
GB	Loch Dun na Cille	L-N2a	0,3	0,2	1,5
GB	Llyn Padarn	L-N2a	0,21	0,2	1,1
GB	Loweswater	L-N2a	0,21	0,2	1,1
GB	Bassenthwaite lake	L-N2a	0,21	0,2	1,1

Too low colour

COUNTRY	NAME	TYPE	COLOR	Lower limit	Ratio
IE	Ballynakill	L-A3	23	30	1,3
NO	Molandsvatnet, NVE nr. 1265	L-N3	25	30	1,2
NO	Noeklevann	L-N3	25	30	1,2

Too high colour

COUNTRY	NAME	TYPE	COLOR	Upper limit	Ratio
IE	Lough Atorick	L-N2a	148	30	4,9
SE	Lake Remmarsjoen	L-N6	97	30	3,2
IE	Lough Dunglow	L-N2a	95	30	3,2
SE	Lake Valasjoen	L-N5	95	30	3,2
NO	Storboerja, NVE-368	L-N6	89	30	3,0
SE	Lake Dalkarlsaspen	L-N6	87	30	2,9
NO	Langtjernet, NVE-7272	L-N6	72	30	2,4
NO	Vermunden, NVE nr. 182	L-N6	68	30	2,3
IE	Lough Doo (Doolough)	L-N2a	65	30	2,2
IE	Lough Easky	L-N2a	63	30	2,1
NO	Nedre Furuvatn, NVE	L-N6	58	30	1,9
SE	Lake Stensjoen	L-N6	58	30	1,9
SE	Lake Sangen	L-N6	58	30	1,9
SE	Lake Vuotnersjoen	L-N5	50	30	1,7
NO	Sognevatnet, NVE-11078	L-N6	48	30	1,6
SE	Lake Degervattnet	L-N6	46	30	1,5
SE	Lake Sundtrasket	L-N6	45	30	1,5
NO	Harasjoeen	L-N6	43	30	1,4
SE	Lake Baktsjaure	L-N5	43	30	1,4
NO	Oeyvannet, NVE-5742	L-N6	41	30	1,4
NO	Indre Espelandsvatnet, NVE-	L-N6	41	30	1,4
SE	Lake Foersjoen	L-N6	41	30	1,4
NO	Holmsjoen, NVE-282	L-N6	37	30	1,2
SE	Lake Limmingsjoen	L-N6	36	30	1,2

3. Coastal and transitional waters

Too low salinity

COUNTRY	NAME	TYPE	Salinity	Lower limit	Ratio

DE	Spiekeroog Wadden Sea	CW-NEA26	20	30	1,5
DE	Wangerooge Open Sea	CW-NEA1	25	30	1,2
EE	Kiguste laht	CW-B12	5,1	6	1,2
DK	Danish Wadden Sea inner	CW-NEA26	28	30	1,1
DE	Hever	CW-NEA26	28,7	30	1,0
DE	Hoernum tidal basin	CW-NEA26	29,1	30	1,0
DE	Amrum	CW-NEA1	29,9	30	1,0

Too high salinity

COUNTRY	NAME	TYPE	Salinity	Upper limit	Ratio
SE	Gaviksfjarden	CW-B0	4,5	3	1,5
SE	The Askoe area (outer part	CW-B3	6,6	6	1,1
NO	Coast of Lista	CW-NEA10	32	30	1,1
FI	Putsaari	CW-B3	6,1	6	1,0

Too short ice-cover

COUNTRY	NAME	TYPE	Ice-cover days	Lower limit	Ratio
SE	Lngvinds- and Skrsfjrden	CW-B2	125	150	1,2
SE	The Bay of Gavle, outer	CW-B2	125	150	1,2
SE	The Coastal area of Ljusnan	CW-B2	125	150	1,2
SE	Harkskars and Trodjefjarden	CW-B2	125	150	1,2
SE	Gaviksfjarden	CW-B0	125	150	1,2

Too small tidal range

COUNTRY	NAME	TYPE	Tidal range	Lower limit	Ratio
DK	West Coast of Jutland -	CW-NEA1	0,5	1	2

Too large tidal range

COUNTRY	NAME	TYPE	Tidal range	Upper limit	Ratio
FR	Baie du Mont-Saint-Michel	CW-NEA26	15	5	3,0
FR	Fond estuarien de la baie du	TW-NEA11	15	5	3,0
FR	Baie du Mont-Saint-Michel	CW-NEA26	13	5	2,6
FR	Chausey	CW-NEA1	9	5	1,8
FR	Anse du Cul de Loup, Anse	CW-NEA26	9	5	1,8
FR	Merville-Franceville	CW-NEA1	7	5	1,4
GB	Conwy Bay	CW-NEA26	7	5	1,4
GB	Cumbria Coast	CW-NEA1	7	5	1,4
FR	Baie des Veys	TW-NEA11	7	5	1,4
GB	Dee Estuary	TW-NEA11	7	5	1,4
NL	Westerschelde	TW-NEA11	7	5	1,4
FR	Tatihou	CW-NEA1	6	5	1,2
FR	Etretat et Senneville	CW-NEA1	6	5	1,2
FR	Cote de Nacre	CW-NEA1	6	5	1,2
GB	North Cornwall Coast	CW-NEA1	6	5	1,2
GB	The Wash (Outer)	CW-NEA1	6	5	1,2
GB	Milford Haven	CW-NEA1	6	5	1,2
GB	St Bride's Bay	CW-NEA1	6	5	1,2
FR	Estuaire de l'Orne	TW-NEA11	6	5	1,2
GB	Humber Estuary (Lower)	TW-NEA11	6	5	1,2
GB	Thames Estuary	TW-NEA11	6	5	1,2
GB	Cleddau Estuary	TW-NEA11	6	5	1,2
NL	Eems-Dollard	TW-NEA11	6	5	1,2
BE	Beneden-Zeeschelde	TW-NEA11	5,64	5	1,1

Appendix 1. Sites with outliers

Too small mean depth

COUNTRY	NAME	TYPE	Mean depth	Lower limit	Ratio
IT	Trappeto	CW-M4	4	50	12,5
IT	Punta Licosa	CW-M2	6	50	8,3
IT	Golfo di Milazzo	CW-M4	7	50	7,1
IT	Imperia	CW-M2	8	50	6,3
SE	Hakefjord and Galteroe	CW-NEA9	8	30	3,8
IT	Punta Mesco	CW-M2	23	50	2,2
GB	Busta Voe, Shetland	CW-NEA7	17	30	1,8
ES	Tossa-Sant Feliu	CW-M2	30	50	1,7
SE	The outer Archipelago of	CW-NEA10	26	30	1,2
SE	N Koevra	CW-NEA10	29	30	1,0

Too large mean depth

COUNTRY	NAME	TYPE	Mean depth	Upper limit	Ratio
GB	Stonehaven, Aberdeen	CW-NEA1	45	30	1,5
GB	Firth of Clyde	CW-NEA26	40	30	1,3
SE	Gaviksfjarden	CW-B0	34	30	1,1

Appendix 2. Availability of data on biological quality elements

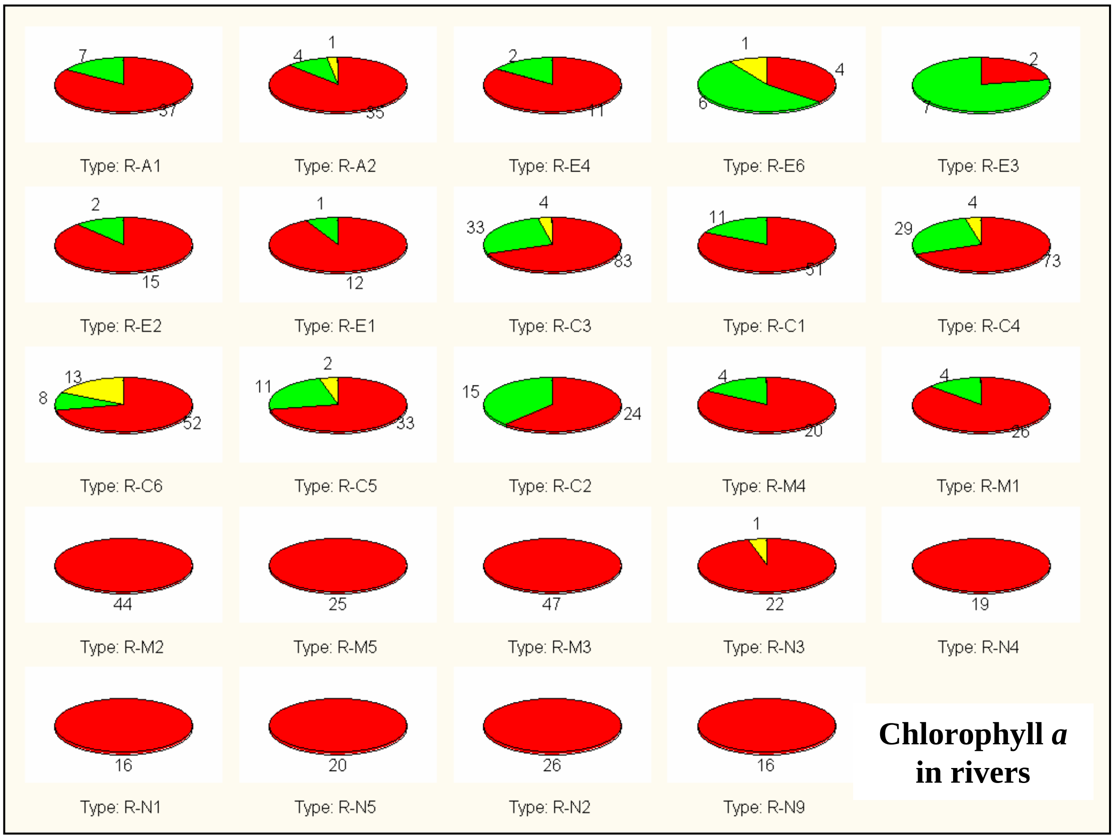
In this appendix the multiple pie charts demonstrate the availability of data on biological quality elements by common intercalibration types (see Table 2 for abbreviations). The following colour codes were used:

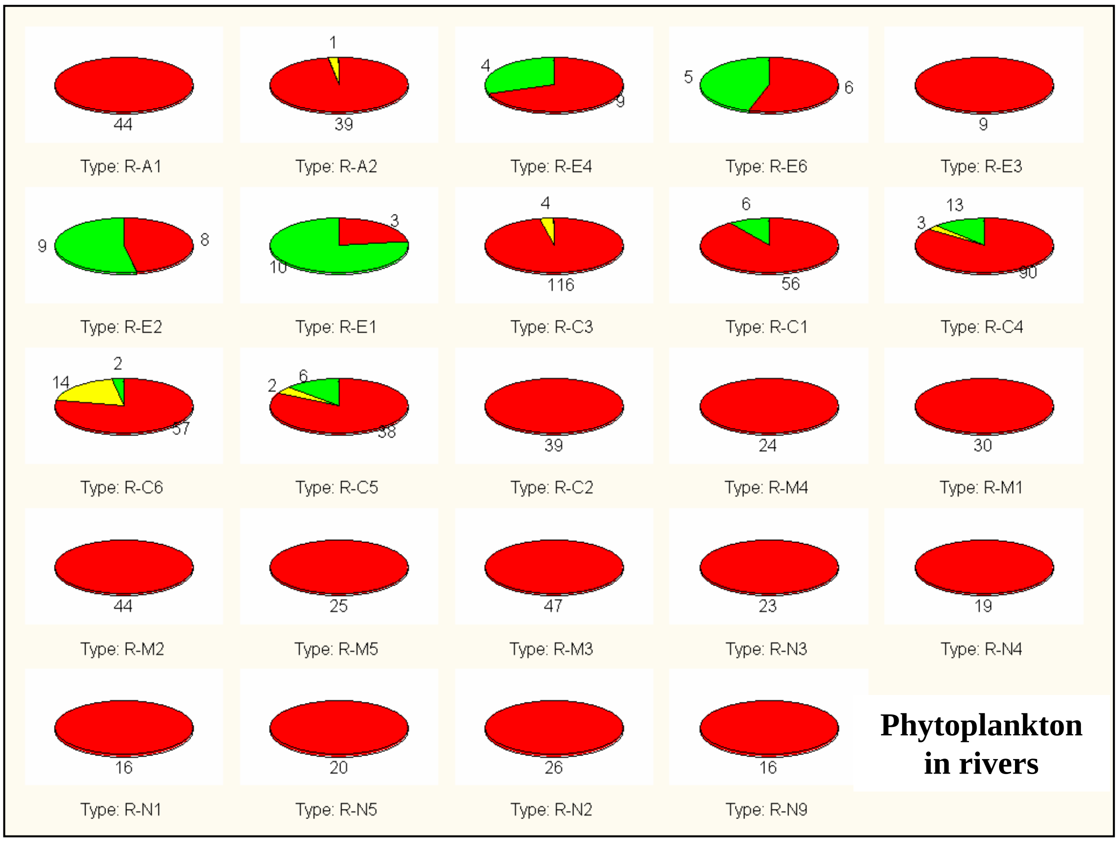
(green)	Data available
(yellow)	No answer yet
(red)	No data available

The numbers at each sector indicate the number of sites.

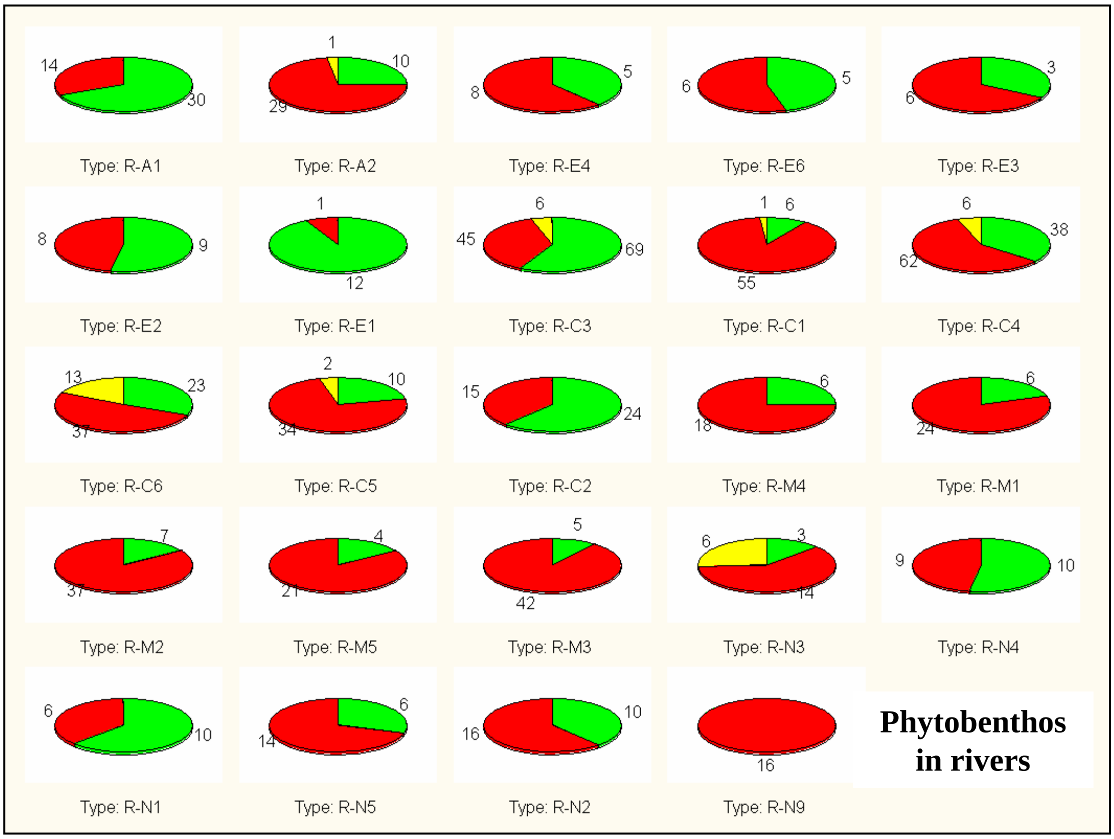
As among transitional waters there is only one type, TW-NEA11, represented by more than two sites, data availability is shown for only this particular type.

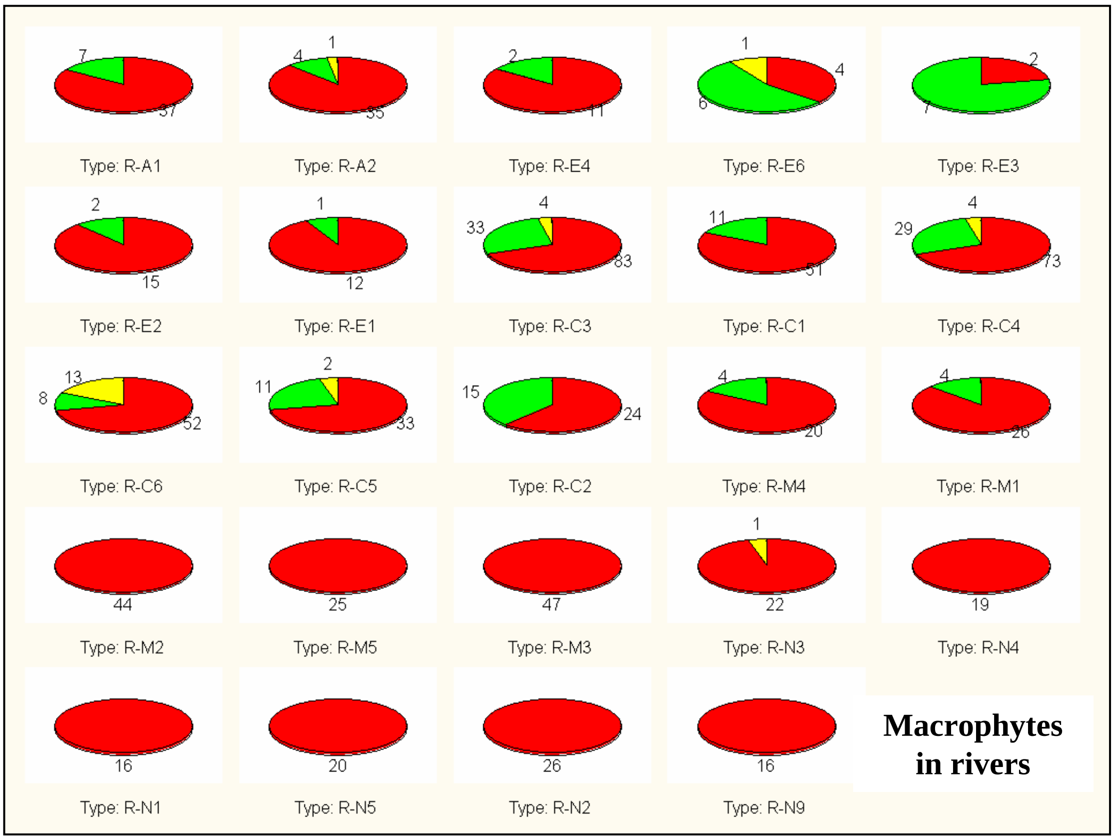
Appendix 2. Availability of data on biological quality elements I-II



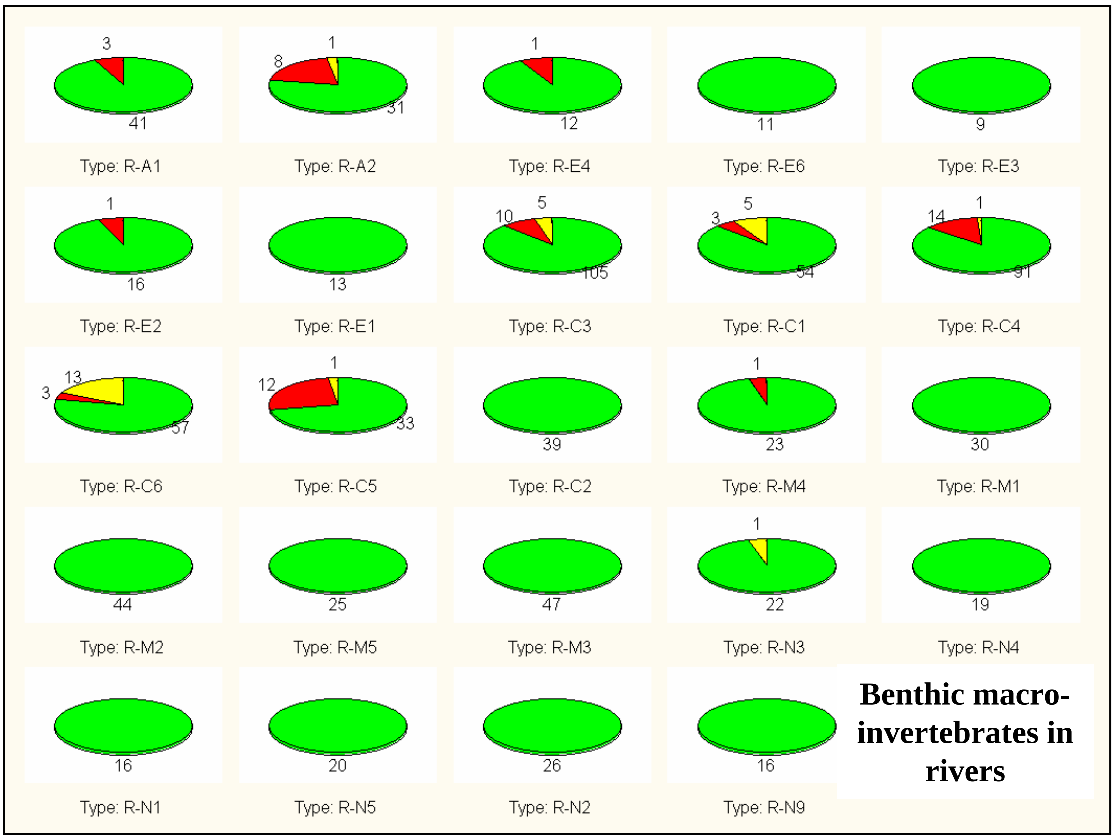


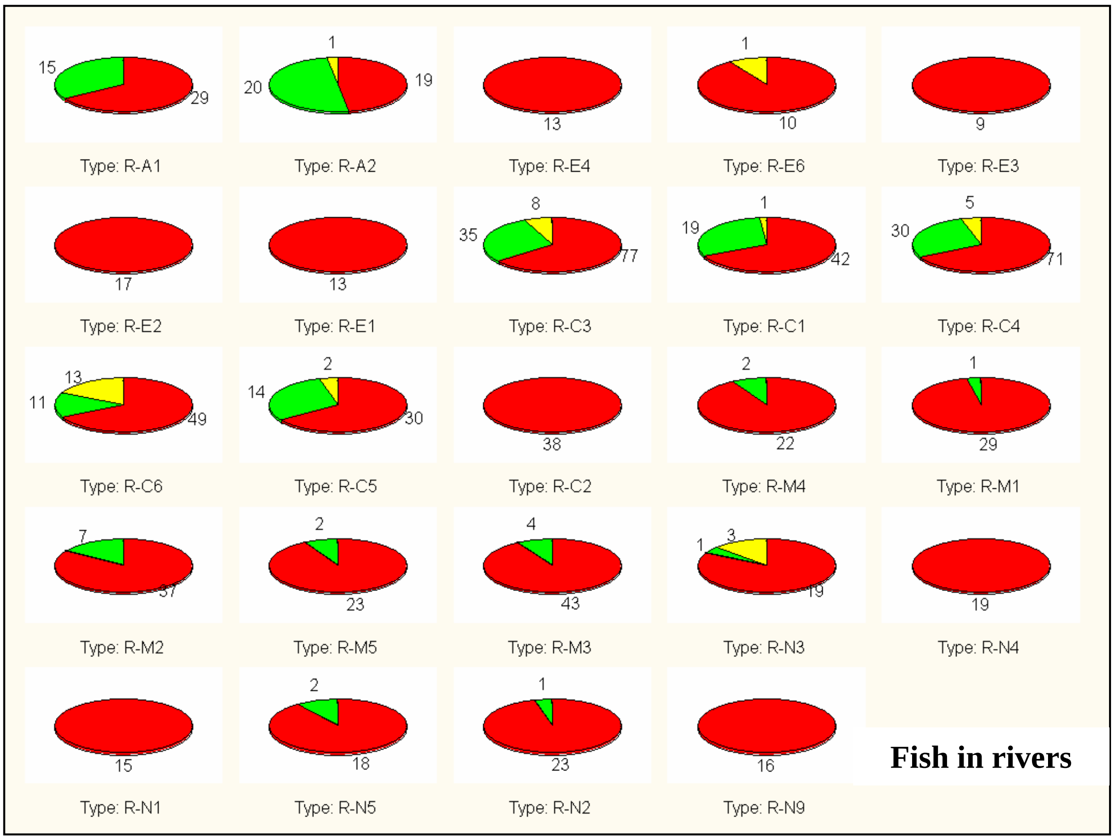
Appendix 2. Availability of data on biological quality elements III-IV



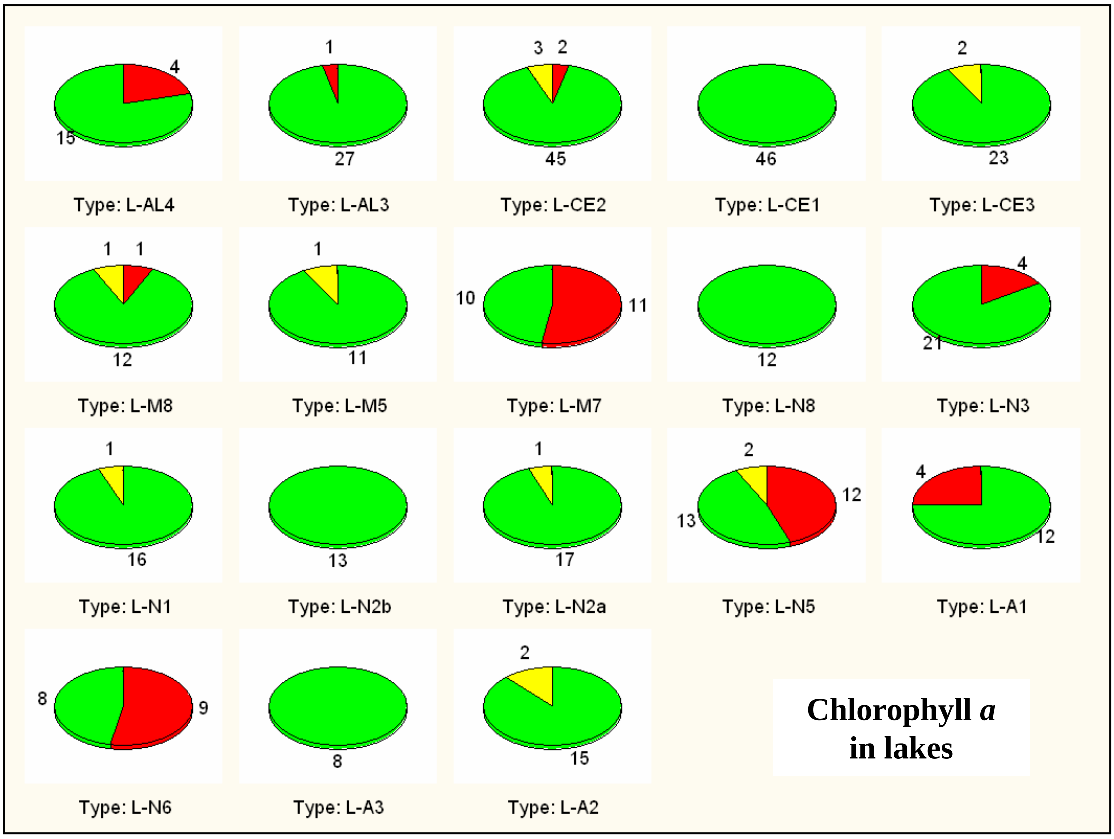


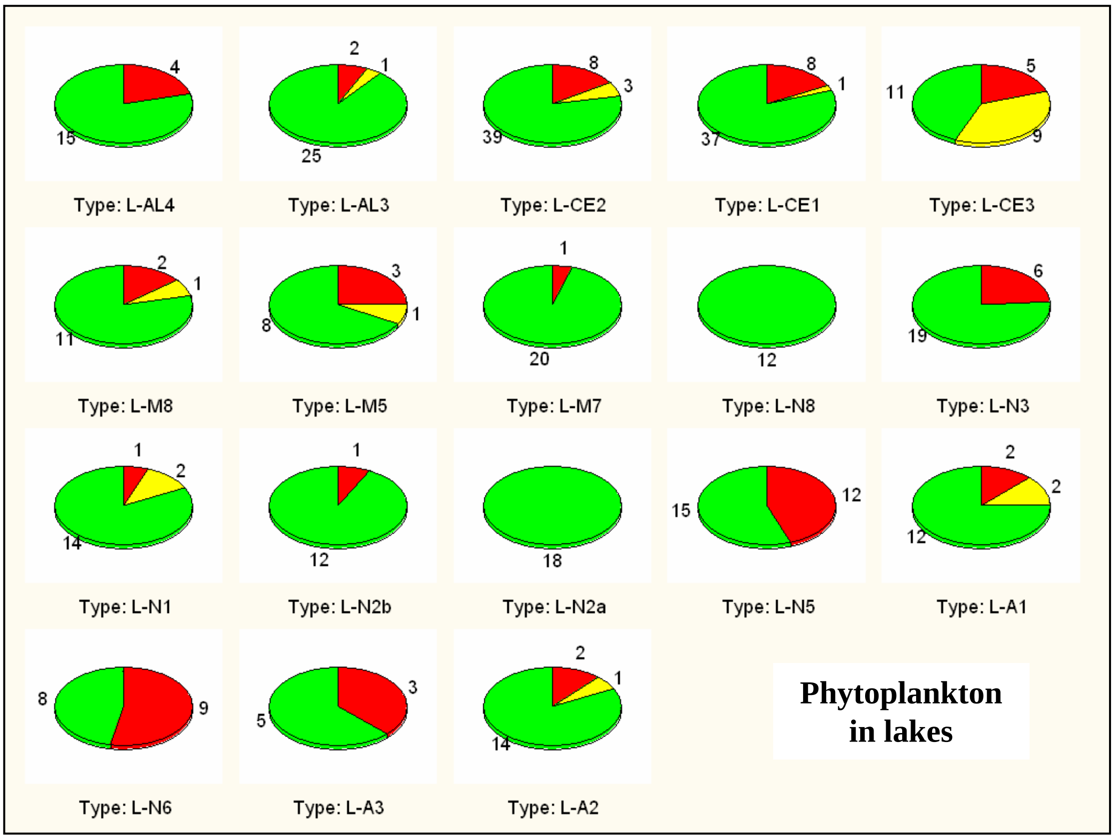
Appendix 2. Availability of data on biological quality elements V-VI



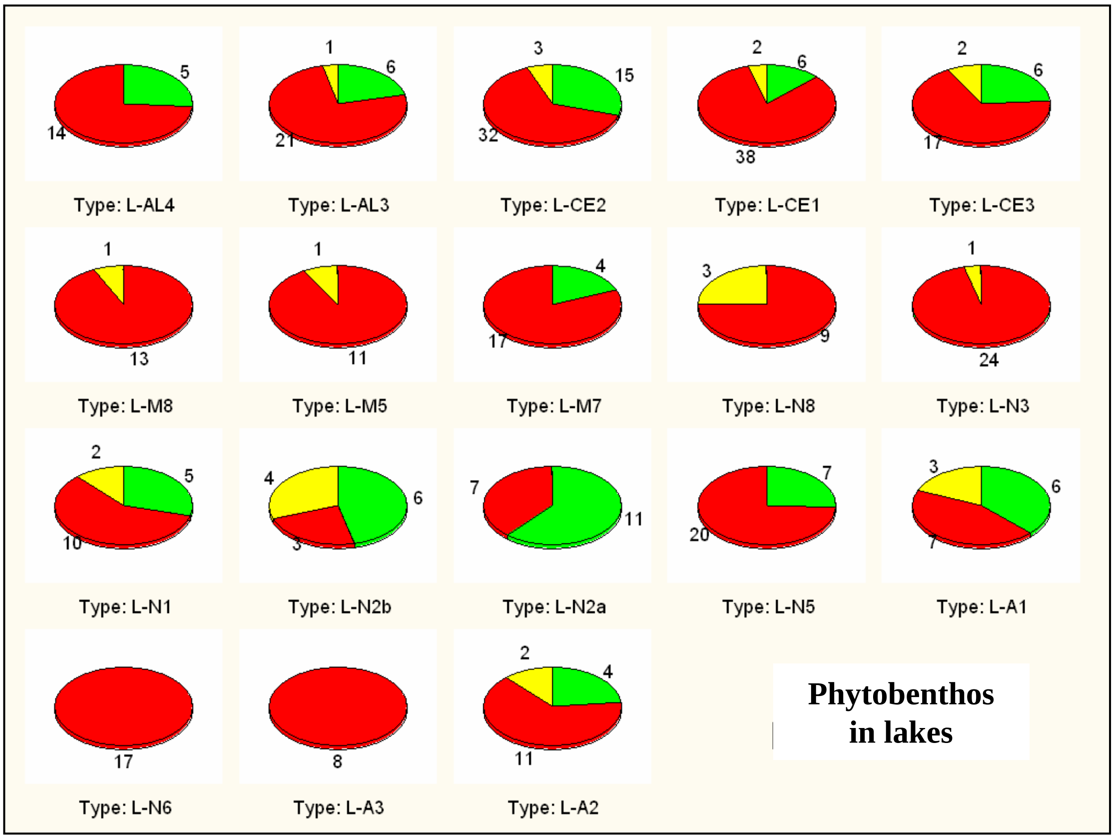


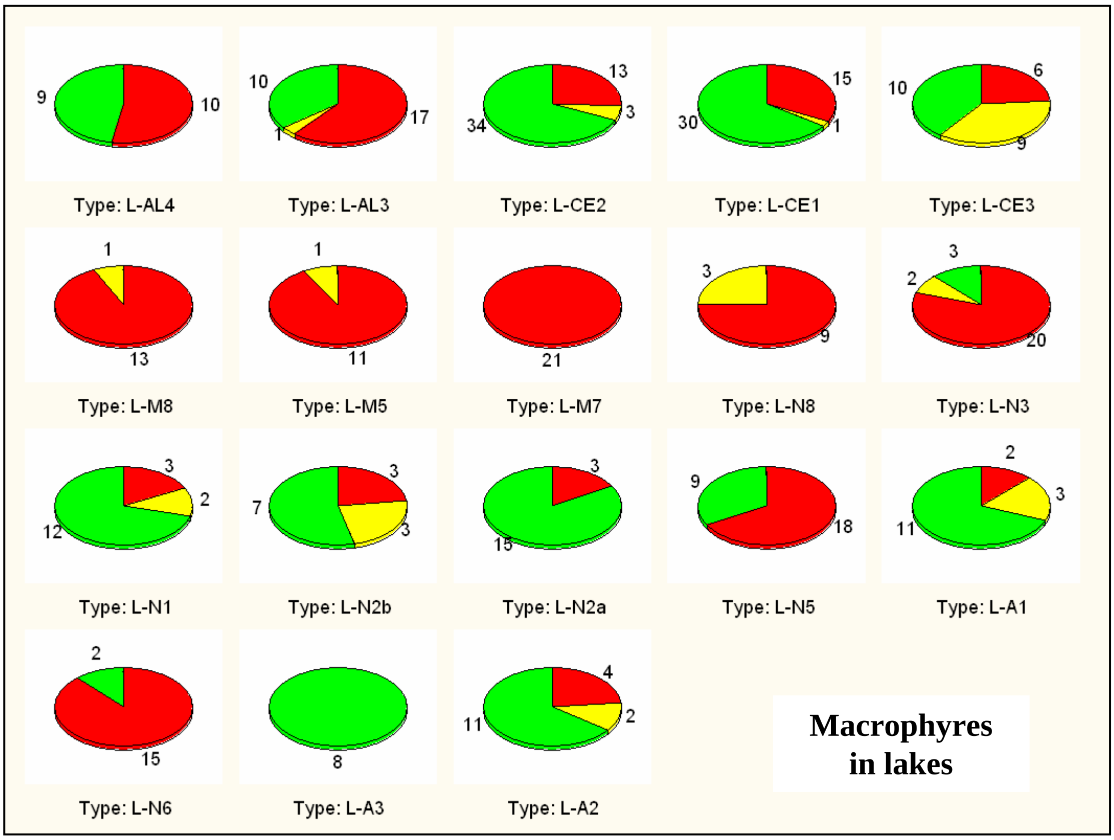
Appendix 2. Availability of data on biological quality elements VII-VIII



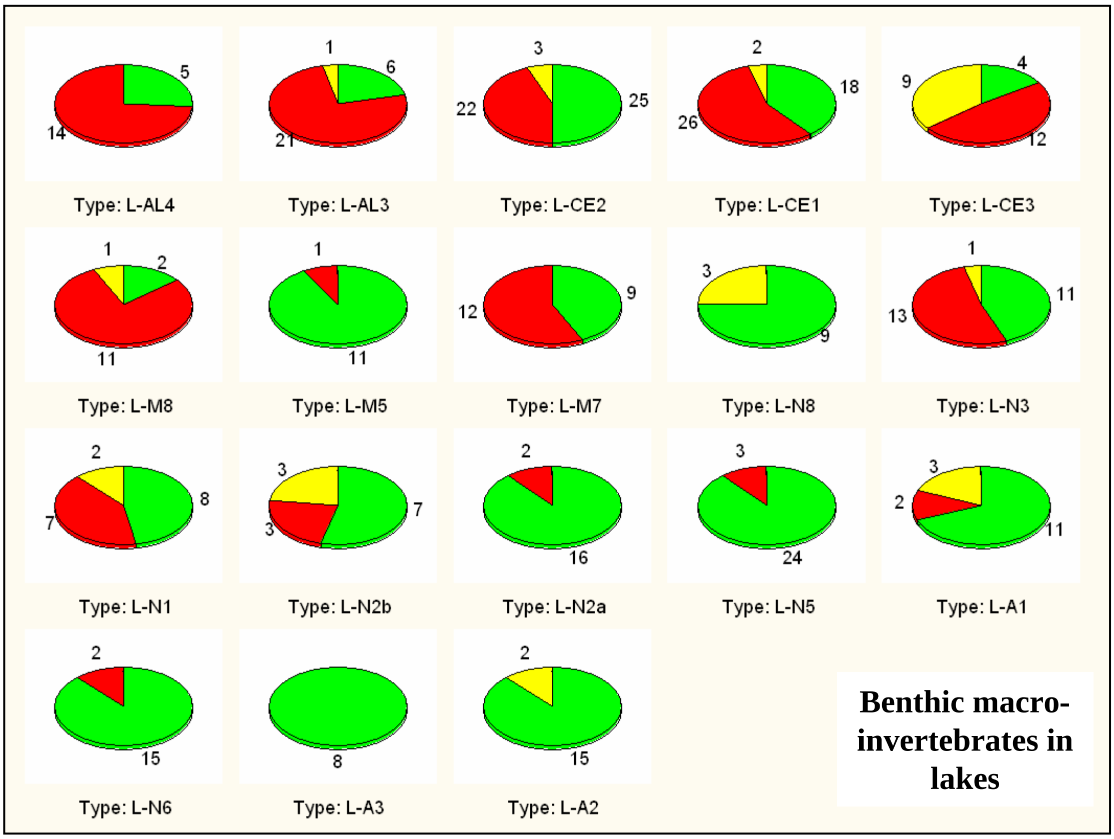


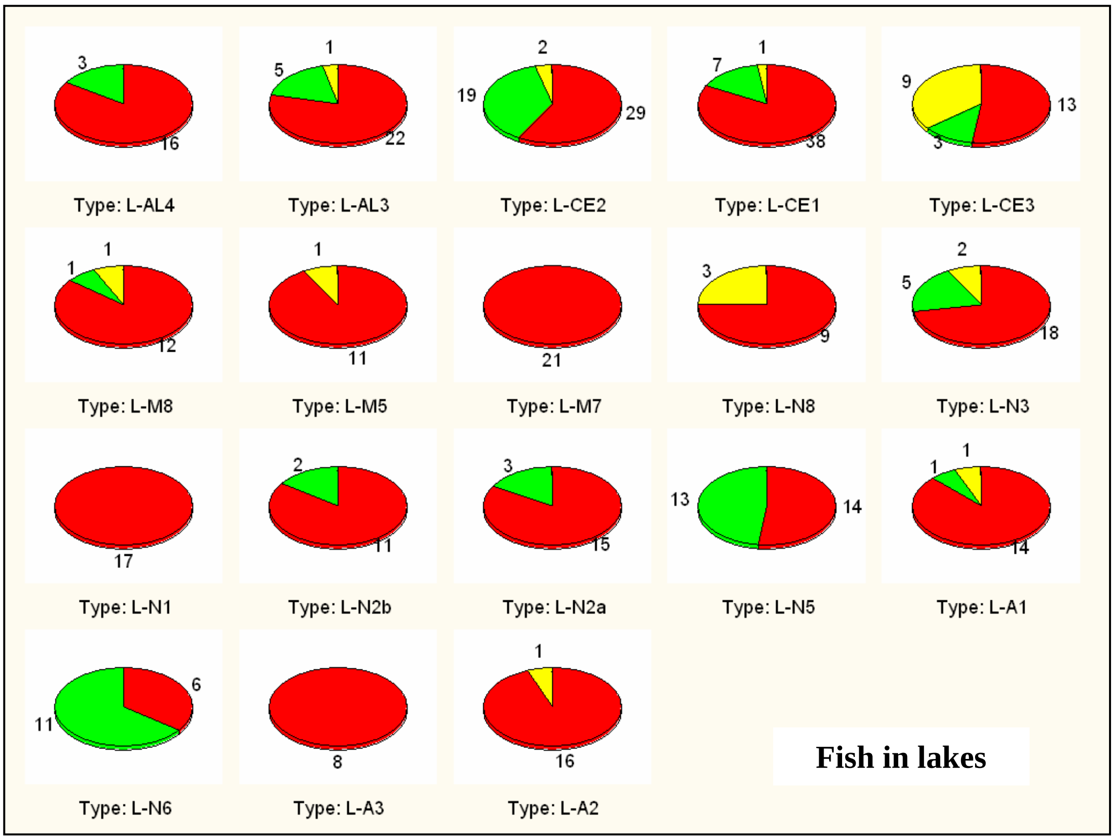
Appendix 2. Availability of data on biological quality elements   IX-X



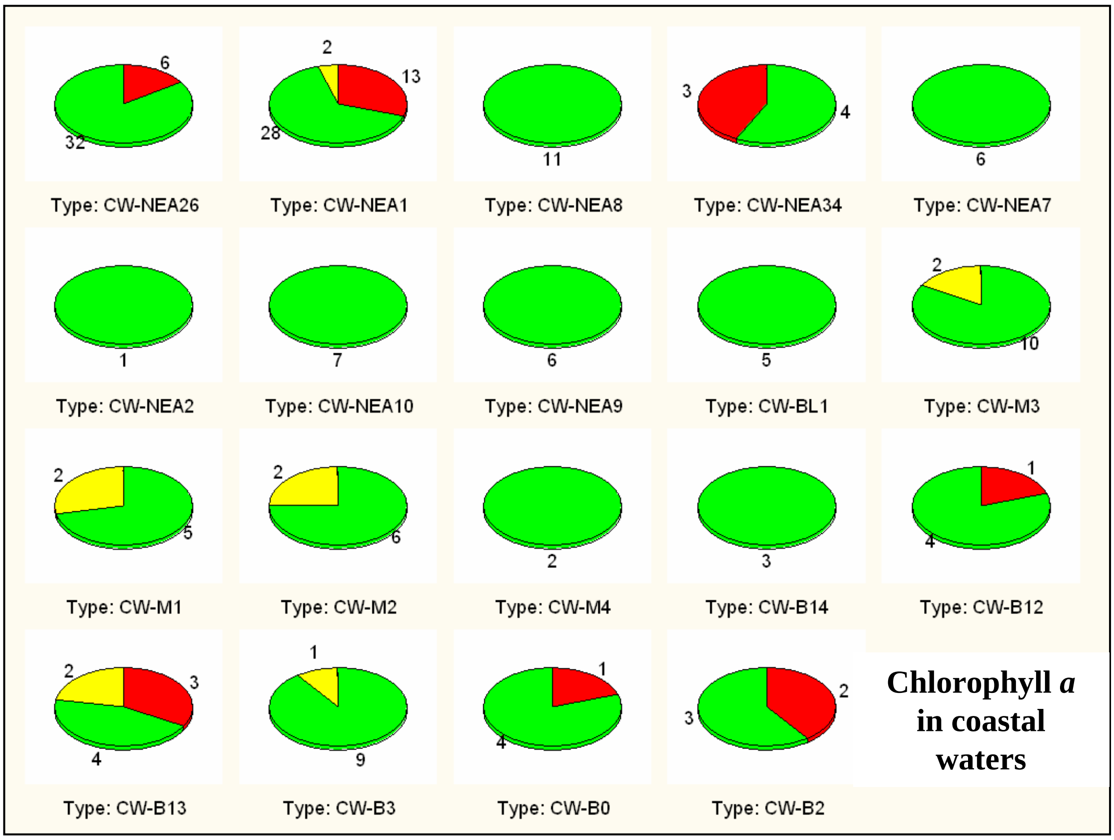


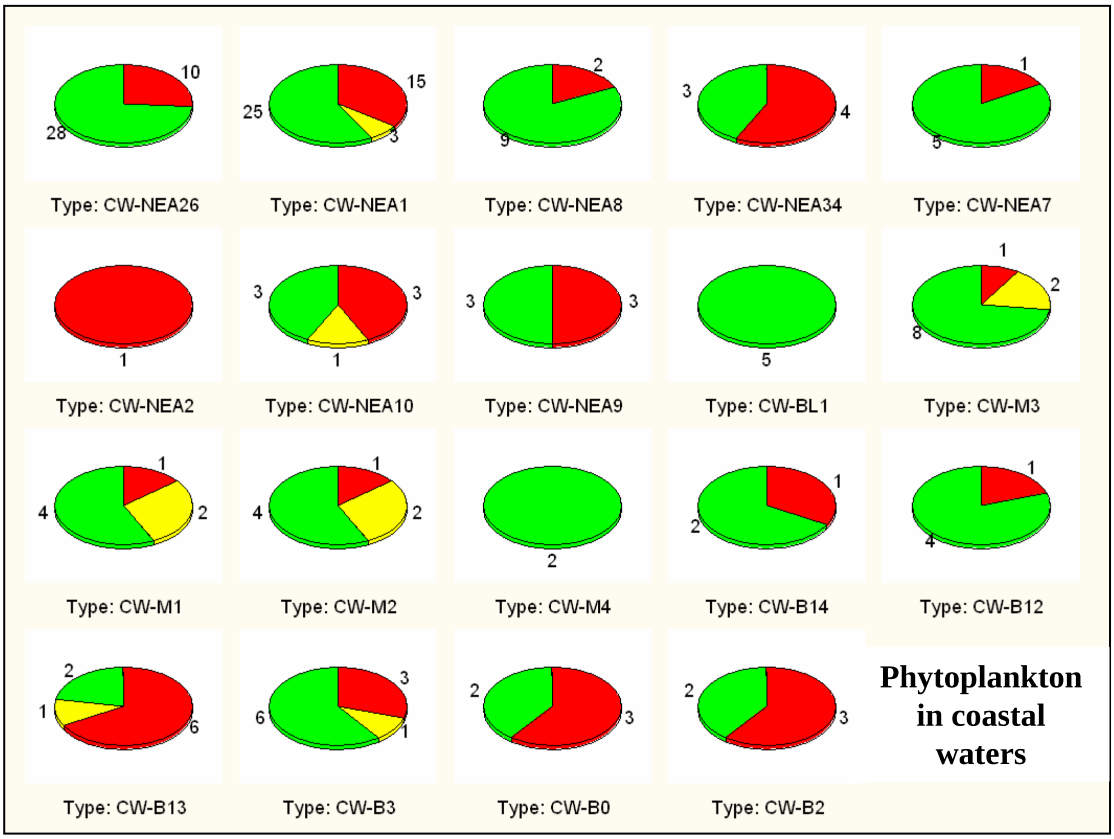
Appendix 2. Availability of data on biological quality elements XI-XII



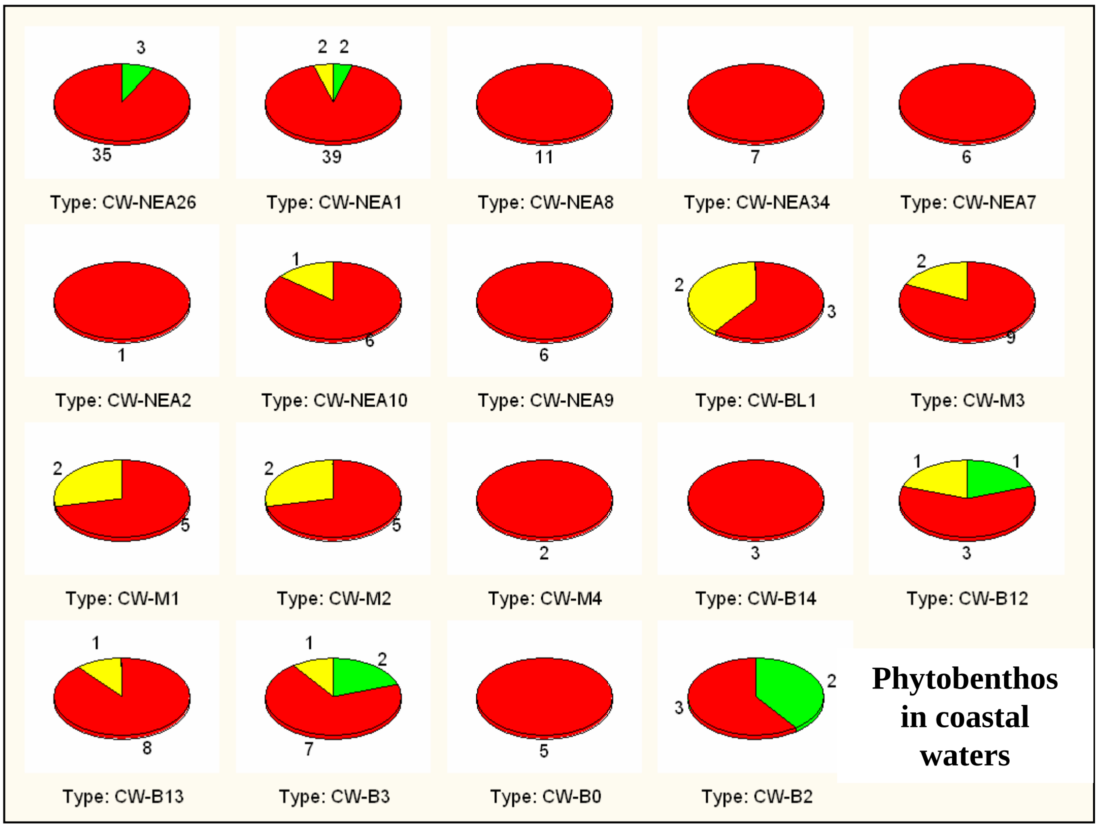


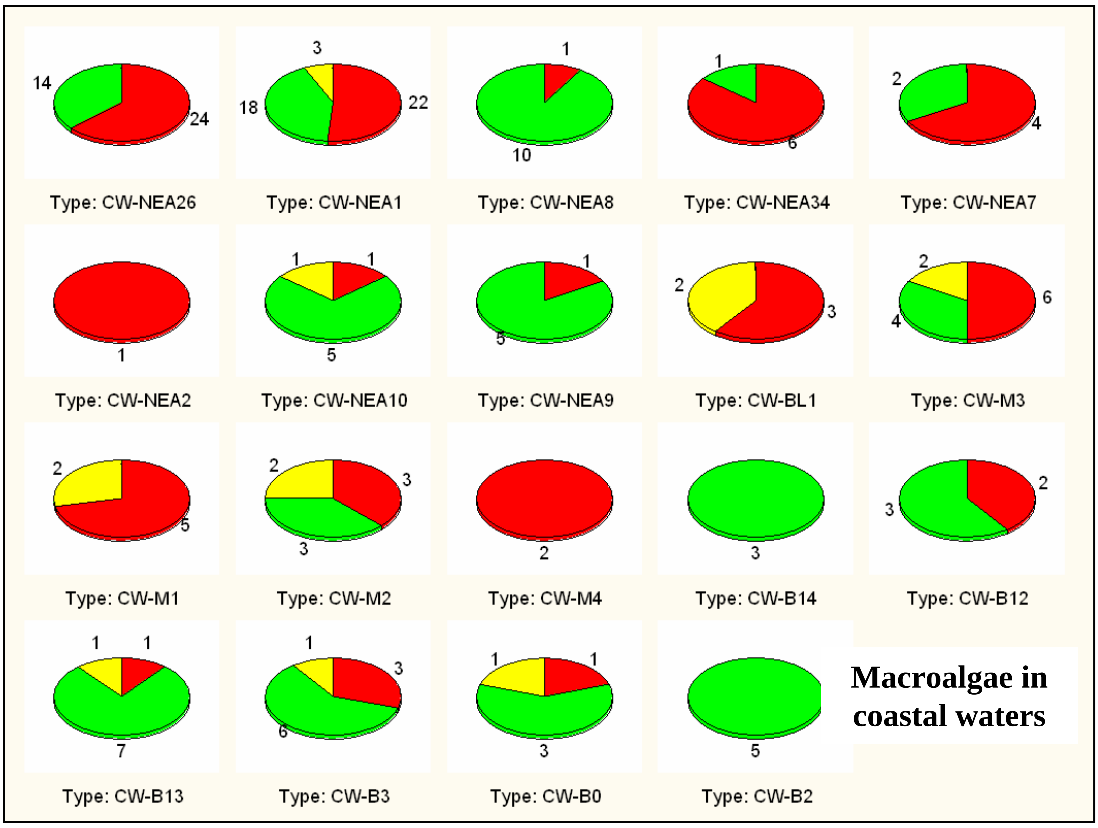
Appendix 2. Availability of data on biological quality elements XIII-XIV



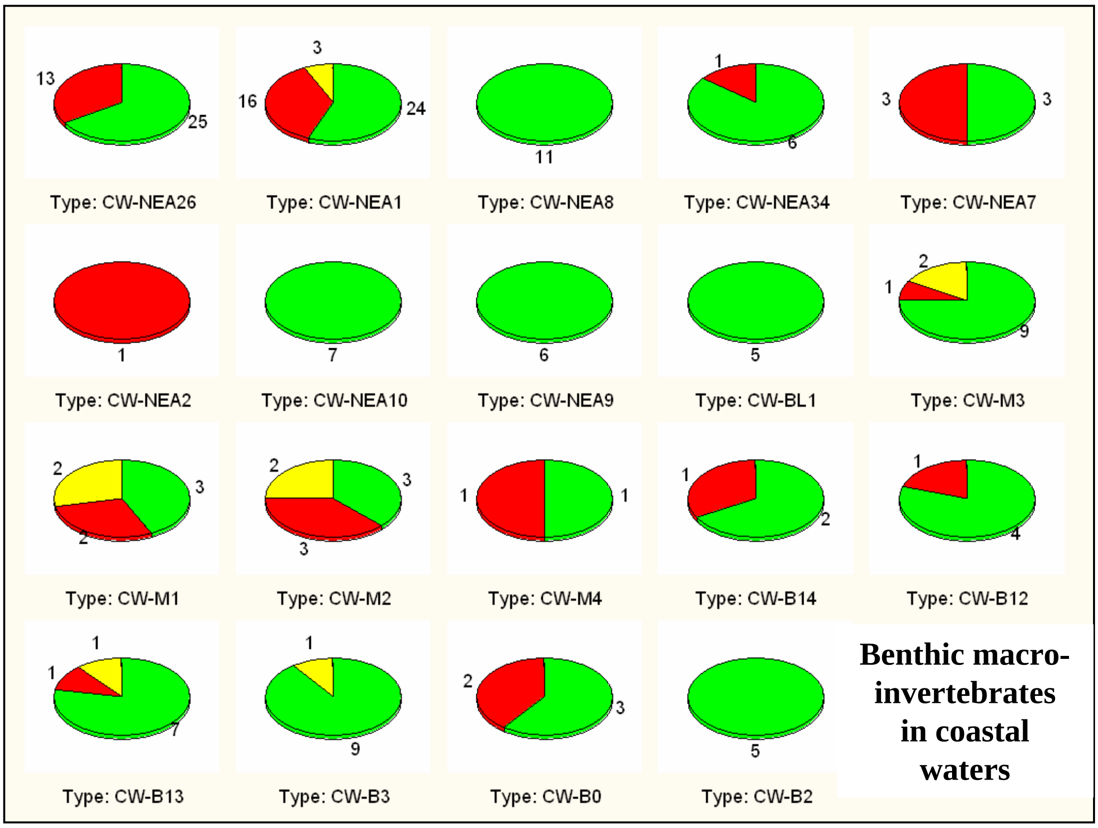


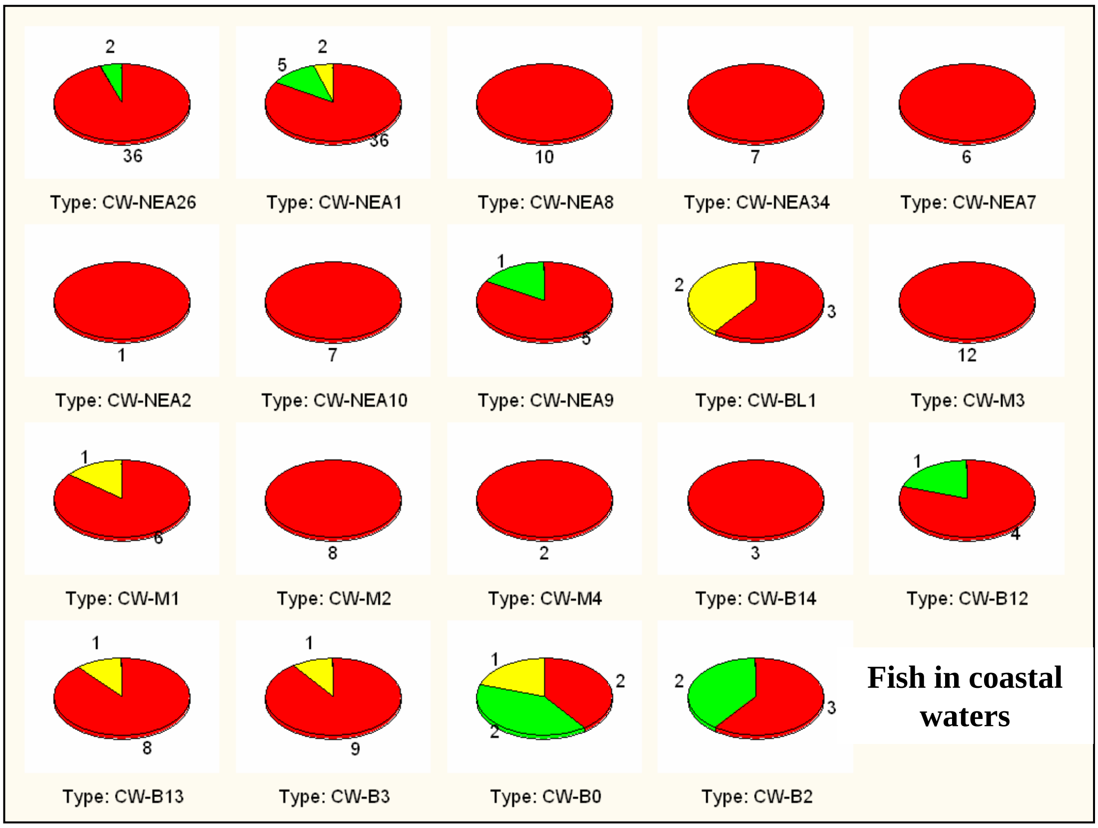
Appendix 2. Availability of data on biological quality elements XV-XVI

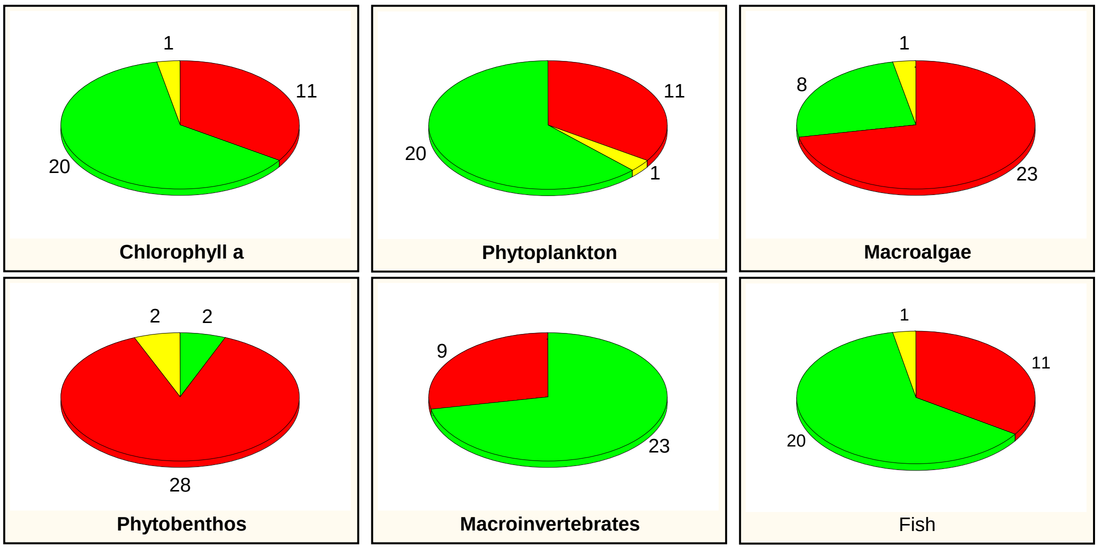




Appendix 2. Availability of data on biological quality elements XVII-XVIII







Availability of data on biological quality elements in transitional water type TW-NEA11

Appendix 3.

Geographical distribution of the availability of reference conditions for the basic quality elements

In this Appendix the following colour codes were used:

Reference conditions established

Reference conditions missing

In order to simplify the search, the following abbreviations were added to the figures:

L – lakes

R – rivers

C – coastal waters

T – transitional waters

TP – total phosphorus

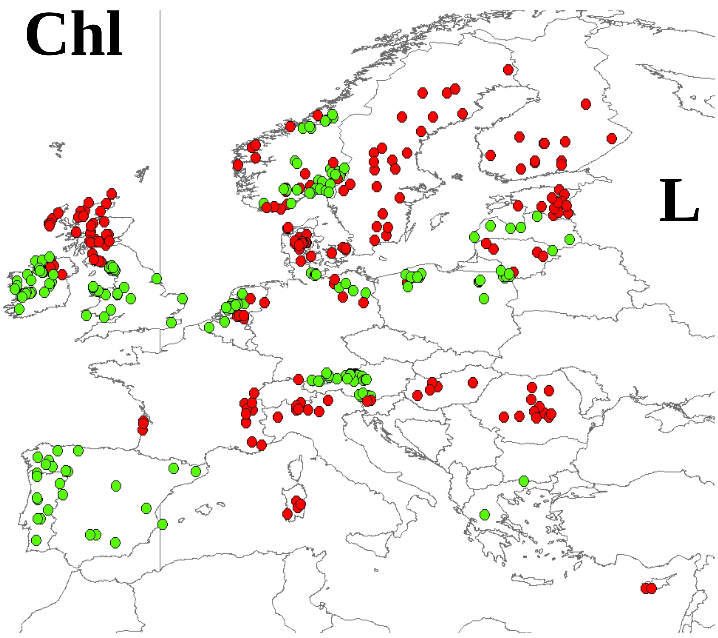
TN – total nitrogen

Chl – chlorophyll

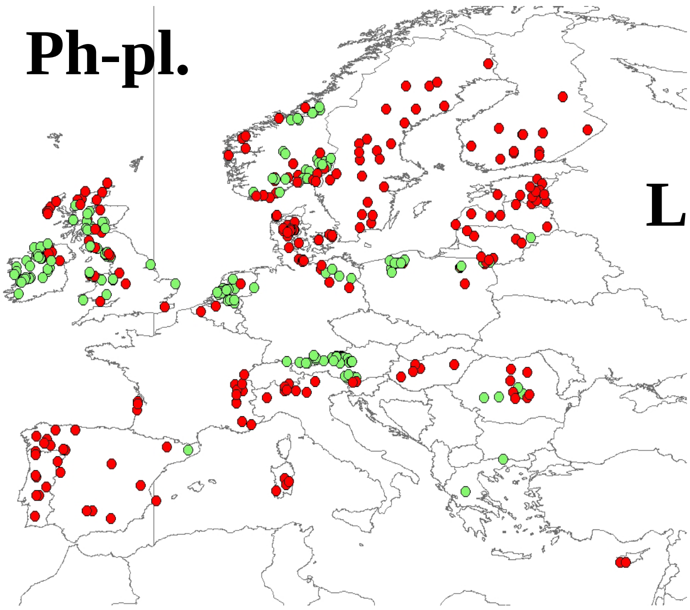
Ph-pl. – phytoplankton

Ph-be. – phytobenthos

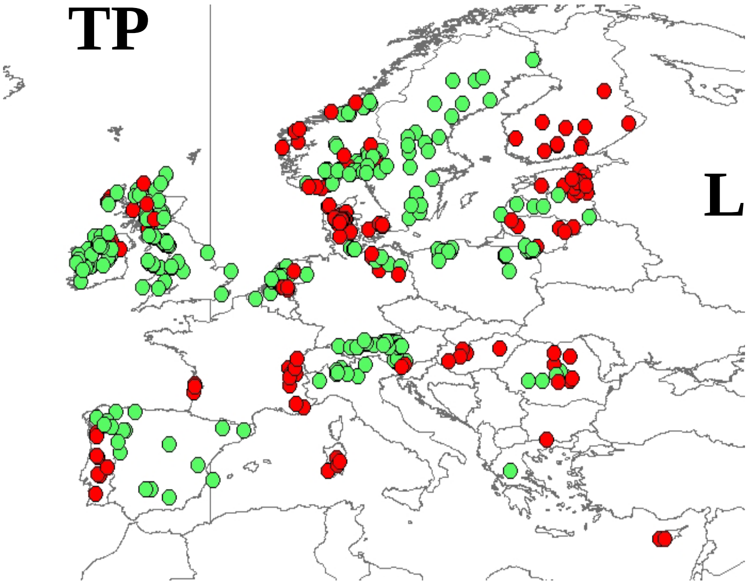
Inv. – benthic macroinvertebrates



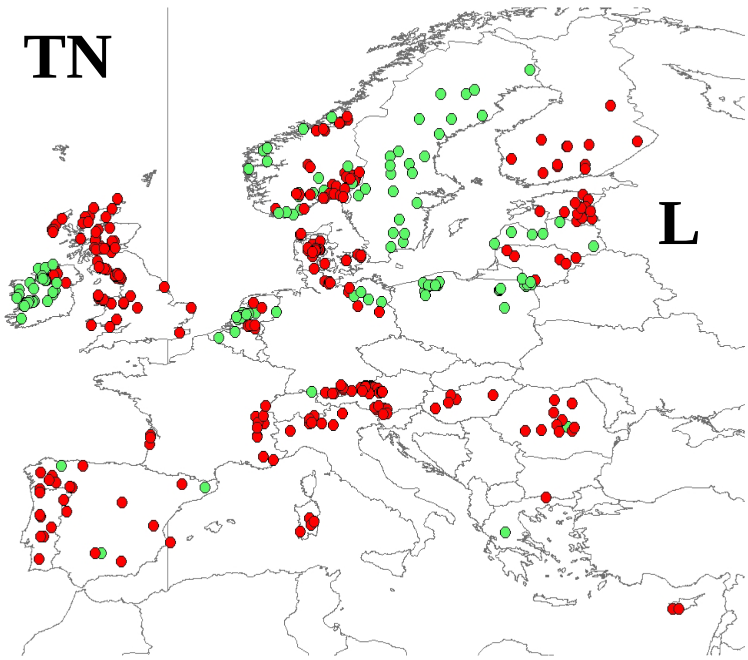
Geographical distribution of the availability of reference conditions for chlorophyll in lakes



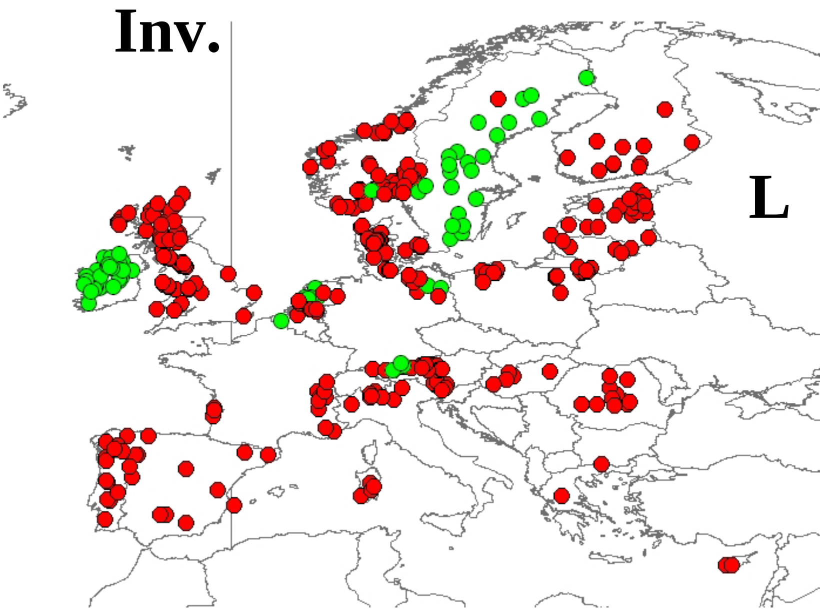
Geographical distribution of the availability of reference conditions for phytoplankton composition in lakes



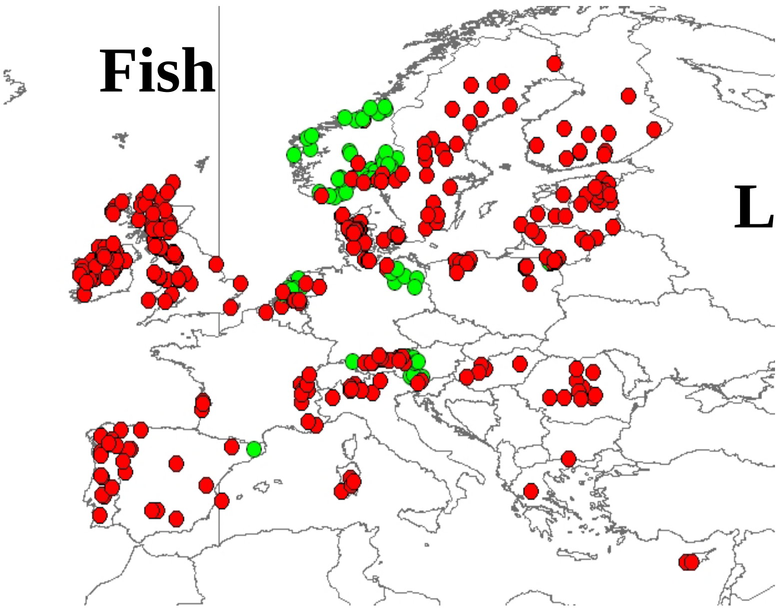
Geographical distribution of the availability of reference conditions for total phosphorous in lakes



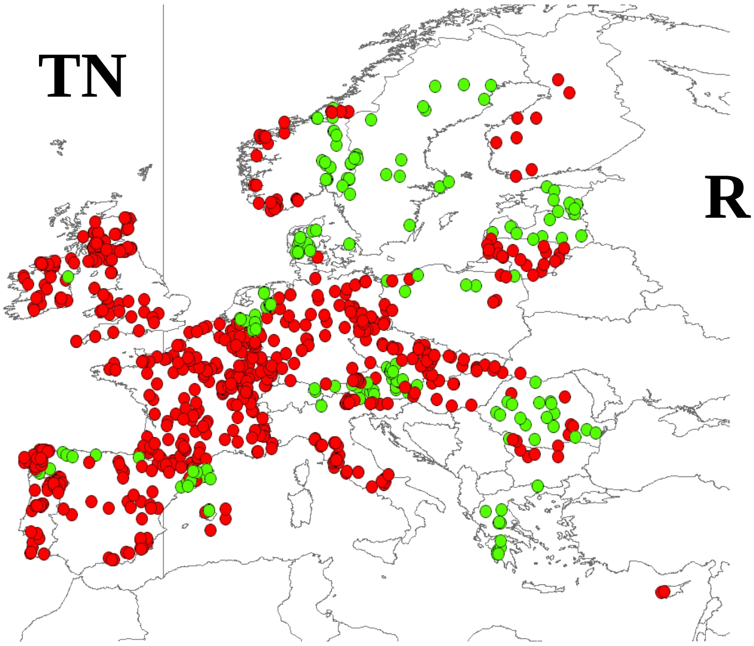
Geographical distribution of the availability of reference conditions for total nitrogen in lakes



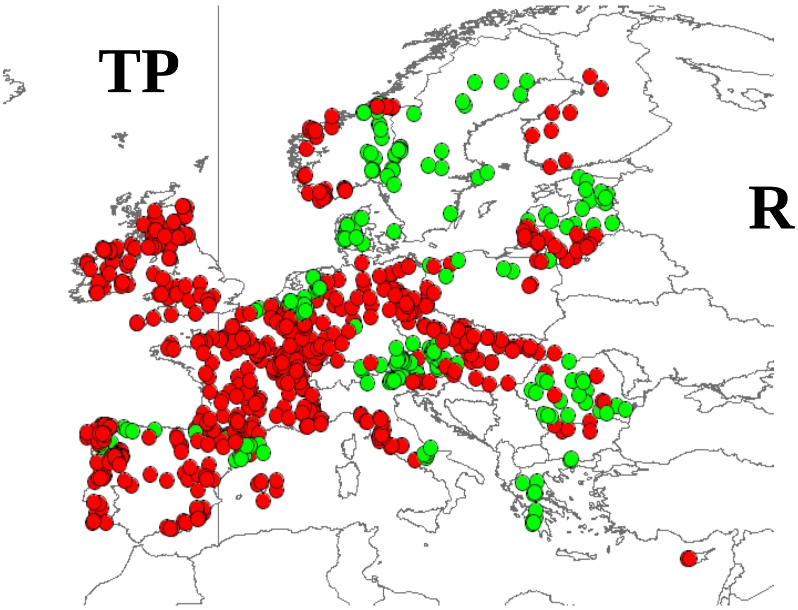
Geographical distribution of the availability of reference conditions for benthic macroinvertebrate diversity in lakes



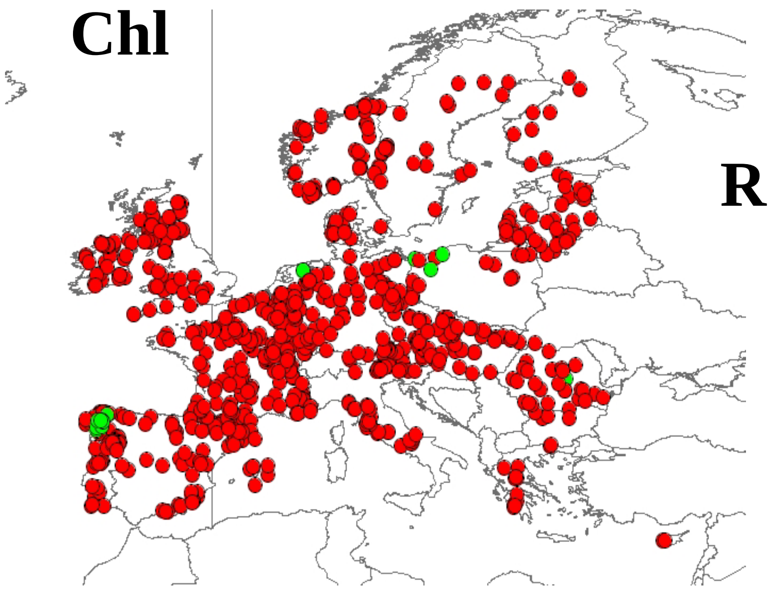
Geographical distribution of the availability of reference conditions for fish species composition in lakes



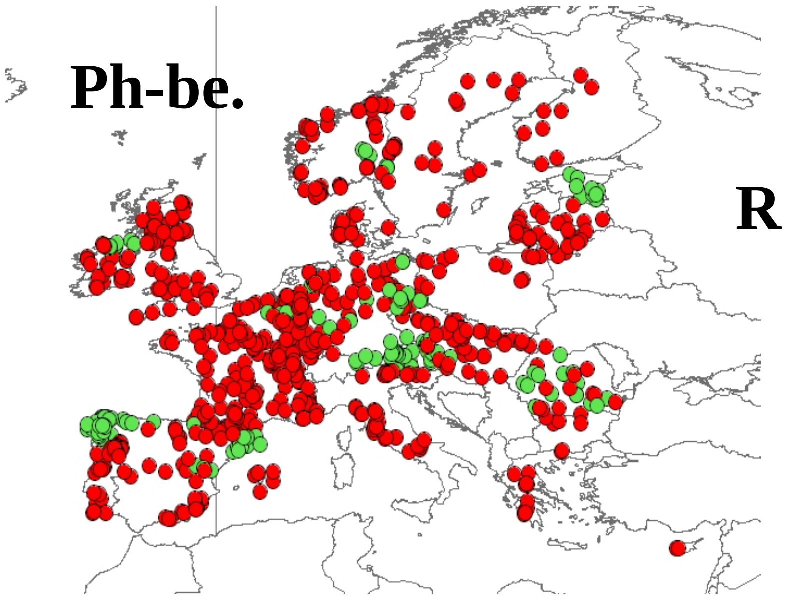
Geographical distribution of the availability of reference conditions
for total nitrogen in rivers



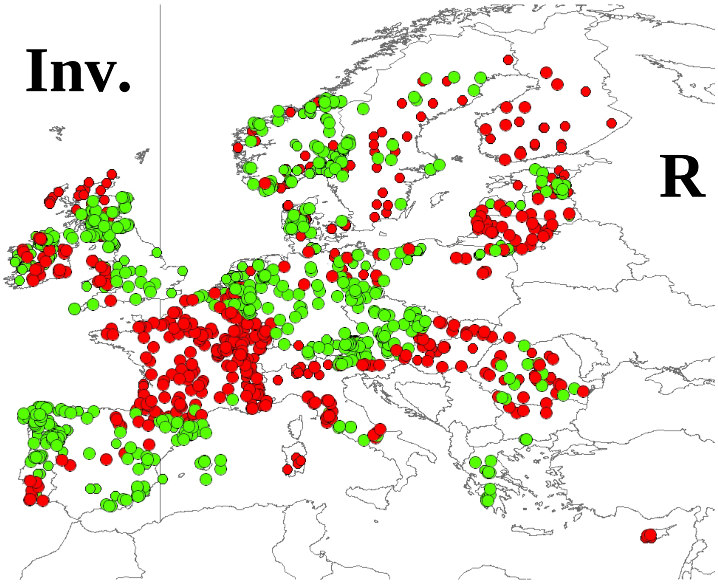
Geographical distribution of the availability of reference conditions
for total phosphorous in rivers



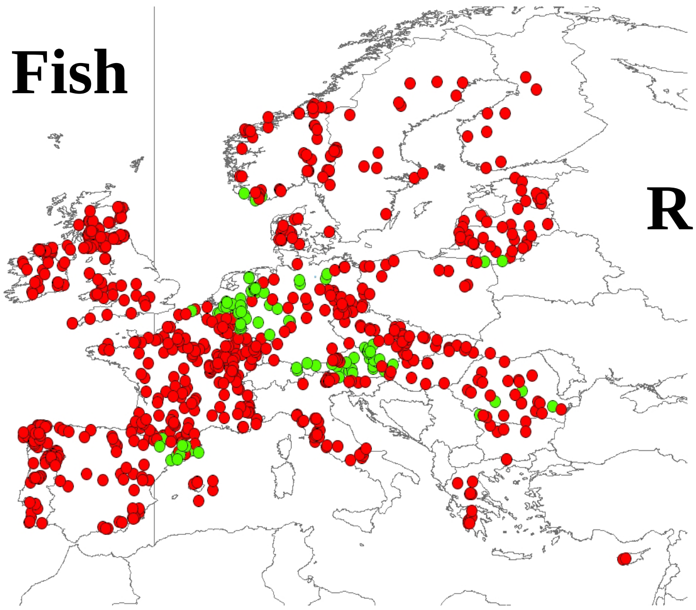
Geographical distribution of the availability of reference conditions for chlorophyll in rivers



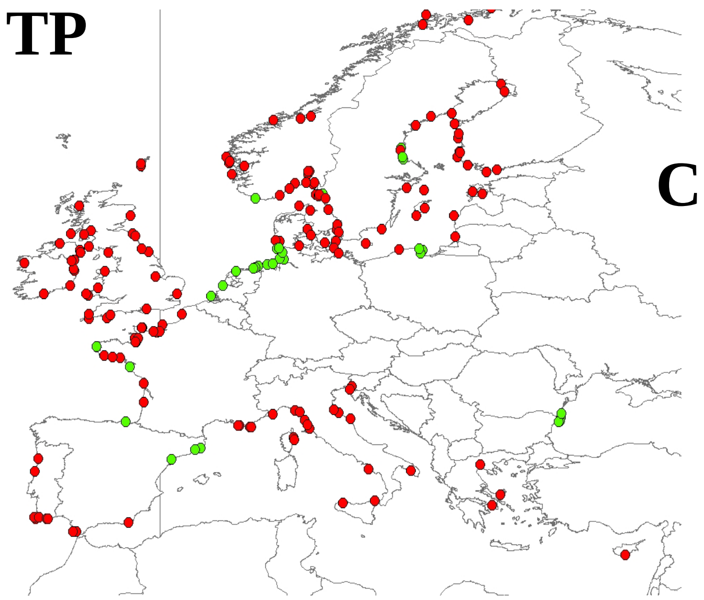
Geographical distribution of the availability of reference conditions for phytobenthos composition in rivers



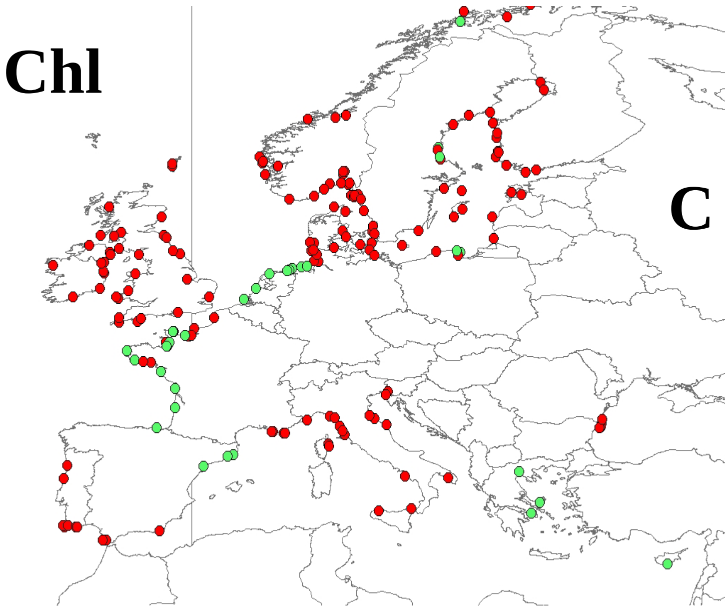
Geographical distribution of the availability of reference conditions for benthic macroinvertebrates in rivers



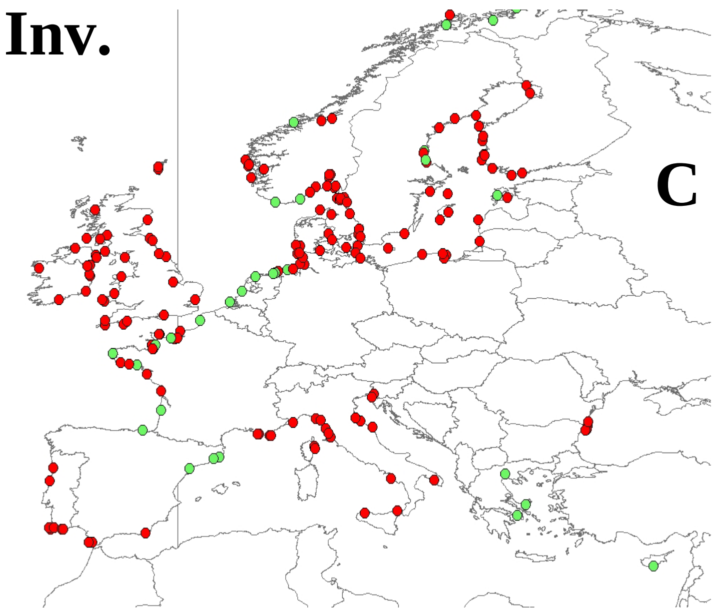
Geographical distribution of the availability of reference conditions for fish species composition in rivers



Geographical distribution of the availability of reference conditions for total phosphorous at coastal sites

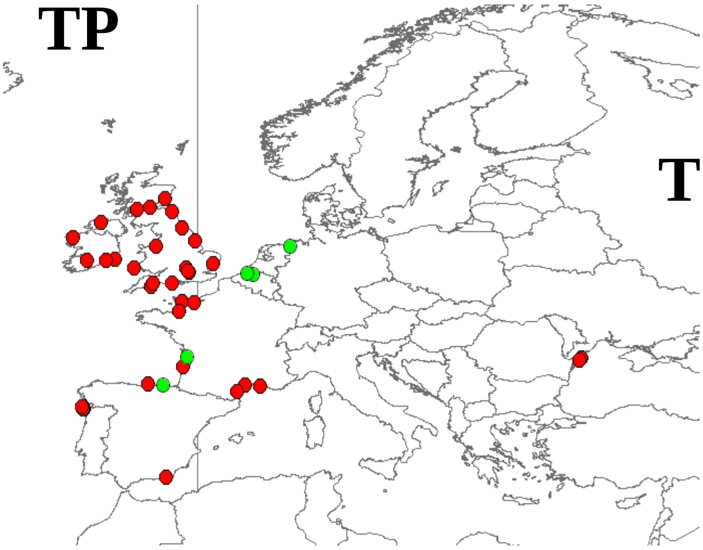


Geographical distribution of the availability of reference conditions for chlorophyll at coastal sites

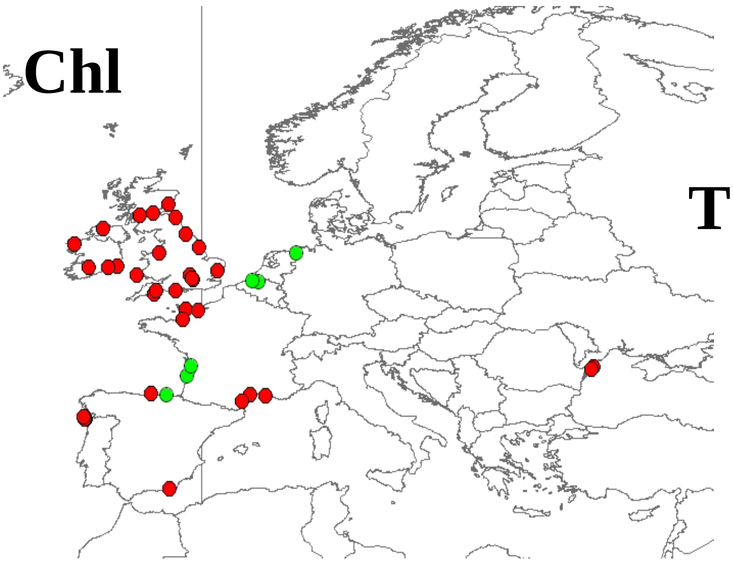


Geographical distribution of the availability of reference conditions for invertebrate diversity at coastal sites

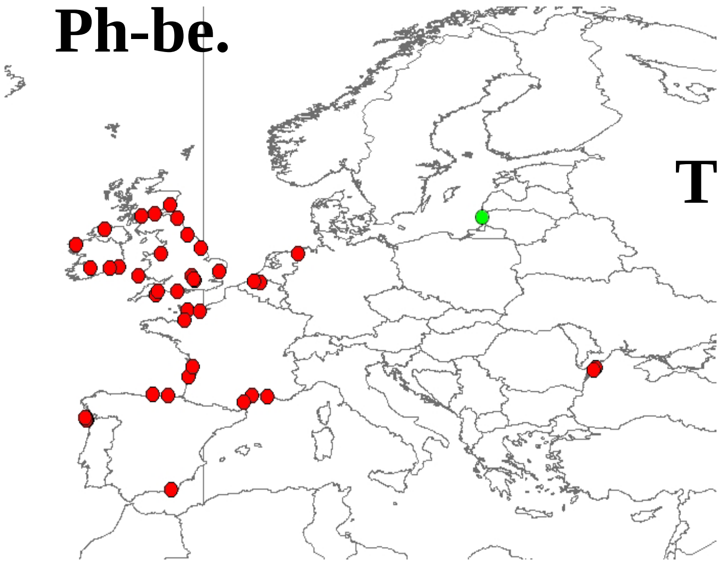
Geographical distribution of the availability of reference conditions for fish species composition at coastal sites



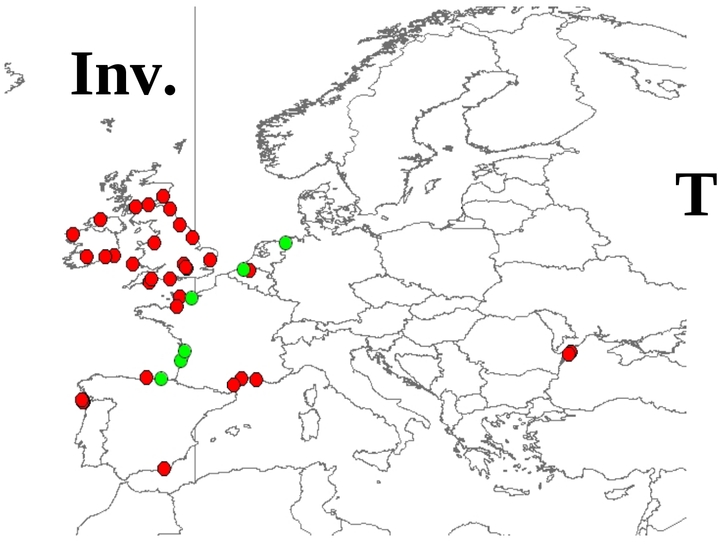
Geographical distribution of the availability of reference conditions for total phosphorous at transitional water sites



Geographical distribution of the availability of reference conditions for chlorophyll at transitional water sites



Geographical distribution of the availability of reference conditions for phytobenthos composition at transitional water sites



Geographical distribution of the availability of reference conditions for diversity of benthic invertebrates at transitional water sites

Appendix 4.

UPDATE OF THE INTERCALIBRATION REGISTER

The dbf file containing the site list and metadata for the intercalibration sites was downloaded for analysis on 26 November 2004 after the official deadline established for site submission to the register. However, some minor changes were made to the register before it was published in the Official Journal of the European Union (L 243 Volume 48, 19 September 2005) not included in the report EUR 21671 N. A summary of the changes in the number of sites by surface water categories is given in Table 1.

Table 1. **Changes in the number of sites in the intercalibration register during six months after the analyses reported in EUR 21671EN**

Surface water category	Number of sites analysed in the report EUR 21671 EN reflecting the state of the register on 26.11.04	Number of sites in the intercalibration register published in the Official Journal (OJ L 243)	Diffe-rence
Rivers	883	872	-11
Lakes	385	383	-2
Coastal waters	190	191	+1
Trans. waters	42	43	+1
Total	1500	1489	-11

Differences between the data analyzed in the present report and the approved network of sites are caused by the following changes in the register from November 2004 to May 2005 (Tables 2-8):

- **Rivers (-11)**

Table 2. **Added river sites (1)**

No. in final register	Country	Site name	GIG	Type	Quality class boundary	ID code
609	MT	Bahrija valley system	RME	R-M5	GM	R4039

Table 3. **Deleted river sites (12)**

Country	Site name	GIG	Type	Quality class boundary	ID code
RO	Ghimbasel	REC	R-E1	GM	R1102
RO	Crisul Negru-us. Poiana	REC	R-E1	HG	R3829
RO	Tarnava Mare	REC	R-E1	GM	R1098
RO	Drincea	REC	R-E2	GM	R1095
RO	Bega	REC	R-E2	GM	R1099
RO	Teslui	REC	R-E2	GM	R1104
RO	Rusavat	REC	R-E2	HG	R1106
RO	Calmatui	REC	R-E2	GM	R601
RO	Casimcea	REC	R-E2	GM	R639
RO	Ier - up. Unimat	REC	R-E2	HG	R3577

RO	Crisul Alb - Baia de Cris	REC	R-E4	GM	R1048
RO	Upstream Arges	REC	R-E6	GM	R3467

- **Lakes (-2)**

Table 4. **Added lake site[1] (1)**

No. in final register	Country	Site name	GIG	Type	Quality class boundary	ID code
1042	SE	Övre Skärsjön	LNO		GM	L3764

Table 5. **Deleted lake sites (3)**

Country	Site name	GIG	Type	Quality class boundary	ID code
RO	Dopca Reservoir	LME	L-M7	HG	L1088
RO	Maneciu Reservoir	LME	L-M7	HG	L1092
RO	Valea de Pesti Reservoir	LME	L-M7	HG	L1093

- **Coastal waters (+1)**

Table 6. **Added coastal water sites (2)**

No. in final register	Country	Site name	GIG	Type	Quality class boundary	ID code
1238	MT	Majjiesa-Raheb	CME	CW-M4	HG	C4037
1239	MT	Fliegu	CME	CW-M4	GM	C4038

Table 7. **Deleted coastal water site (1)**

Country	Site name	GIG	Type	Quality class boundary	ID code
GB	Loch Ryan (site 1)	CNE	CW-NEA26	GM	C300

- **Transitional waters[1] (+1)**

Table 8. **Added transitional water site (1)**

No. in final register	Country	Site name	GIG	Type	Quality class boundary	ID code
1294	UK	Conwy Estuary	CNE	TW-NEA11	HG	T3881

[1] The xml files for the Swedish Lake Övre Skärsjön and for the UK transitional site Conwy Estuary were corrupted and the sites did not occur in the dbf file created for analysis. Despite the problem with the files, the sites were still included in the Final Intercalibration Register

One site in the list is doubled: the same site was erroneously submitted as a coastal and also as a transitional water site (Table 9) and it still remains in the published intercalibration register.

Table 9. **A double site as it was included in the final intercalibration register**

No. in final register	**Water category**	**Country**	**Site name**	**GIG**	**Type**	**Quality class boundary**	**ID code**
1174	Coastal/ Transitional	FR	Arcachon amont	CNE	CW-NEA26	GM	T933
1175	Coastal/ Transitional	FR	Arcachon Amont	CNE	CW-NEA26	GM	C3835