River Fish Intercalibration Group WFD Intercalibration Phase 2: Milestone 1 report. Report to the European community,

Didier Pont, M. Beers, T. Buijse, Olivier Delaigue, T. Ferrera, N. Jepsen, V. Kovac, M. Schabuss, P. Segurado, C. Schuetz, et al.

EUROPEAN COMMISSION
DIRECTORATE GENERAL JRC
JOINT RESEARCH CENTRE
Institute of Environment and Sustainability

River Fish Intercalibration Group

WFD Intercalibration Phase 2 : Milestone 1 report

September 2009

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Water category/GIG/BQE/ horizontal activity:	**RIVER FISH IC GROUP**
Information provided by:	Pont D., M. Beers, T. Buijse, O. Delaigue, T. Ferrera, N. Jepsen, V. Kovac, M. Schabuss, P. Segurado, C. Schuetz, T. Vehanen

1: Organisation

1.1. Responsibilities and participation

Please indicate how the work is organised, indicating the lead country/person.

In continuation of our pilote exercice during the first IC round, it has been also decided that for the pilot exercise it was not necessary to organise this work within the already existing Geographical Intercalibration Groups (GIG's). However, it seemed relevant to make regional groups that were responsible for the exchange of data and the reporting of the results. The main difference being that the process is centrally guided and that all data are submitted to the central database to facilitate comparisons between the national methods and the common metrics.
In the same way, we decided to use both the options 2 (common metrics approach) and 3 (direct national classification comparison within regional groups). The option 2 is used at the European level, at least to ensure the comparability of reference condtions between countries and regions.

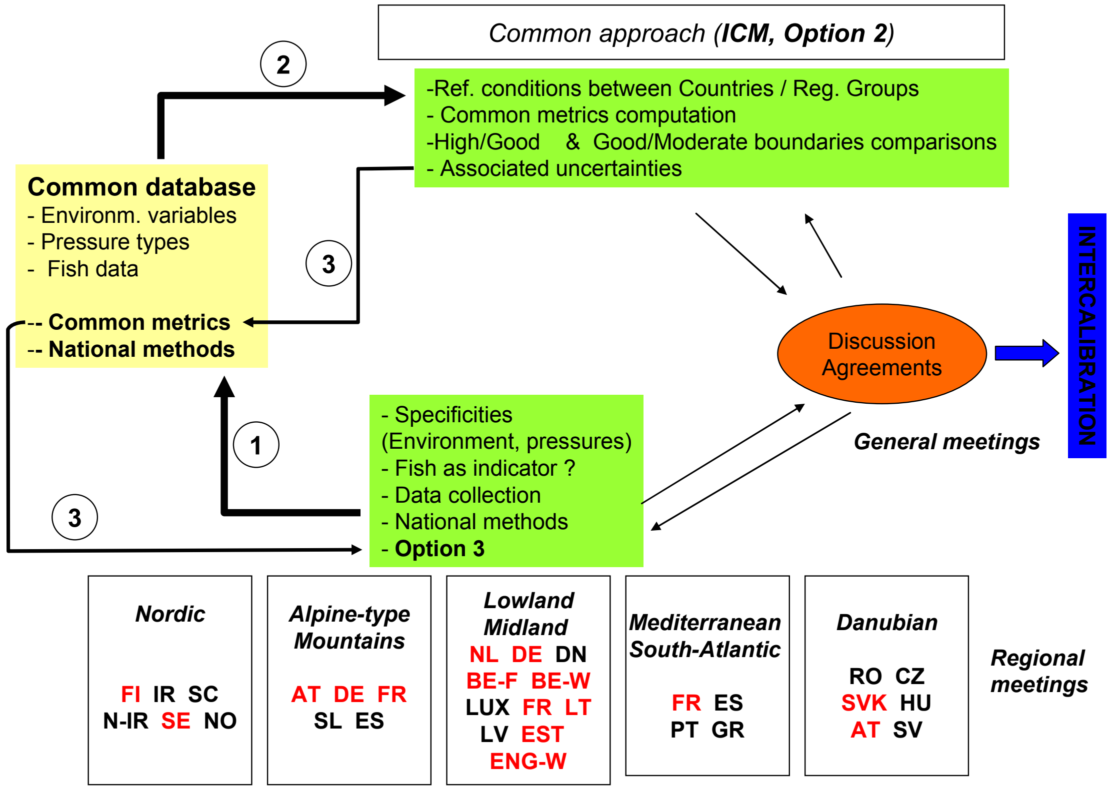
26 Participants / Member States are involved:
Austria, Belgium-Wallonia, Belgium-Flanders, Czech Republic, Denmark, England-Wales, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Latvia, Lithuania, Luxemburg, Netherland, Northern Ireland, Norway, Portugal, Romania, Scotland, Slovakia, Slovenia, Spain, Sweden

Organization of the work:

Since the beginning of 2009, the leader of the whole group is Didier Pont (Cemagref, France) with the help of Olivier Delaigue (Cemagref, France, Common Database Management).

The five regional groups are coordinated by:
Nordic Group: Teppo Vehanen
Lowland-Midland Group: Tom Buijse and Cornelia Schuetz (and with Marco Beers)
Alpine-type Mountains Group: Mickael Schabuss
Mediterranean South-Atlantic: Teresa Ferrera (with Pedro Segurado)
Danubian Group: Vladimir Kovac

Cemagref (France) is in charge of the development of the common metrics.



Are there any difficulties with the participation of specific Member States? If yes, please specify

Some member state could not participate due to the lack of national funding.

In addition, a large number national methods for river assessment using fish are always in development (e.g. Spain, Portugal, Scotland and Northern Ireland,…) or in revision (e.g. France).

The large rivers (mainly large floodplain rivers) are not considered in this second round. The participants plan to deal with this river type in 2011 and after, in close coordination with the large river assessment group coordinated by F. Schöll.

For these different reasons, the River Fish IC process will continue at least in 2011.

1.2. Work plan, Timetables and deadlines

Annex 1 to this questionnaire contains the the GIG work plans as presentedat ECOSTAT in April 2008 Please provide an updated version the general work plan for your GIG below

GIG All river GIGs Last update: 2009-09-19
Quality element Fish
Overview of results achieved to date and issues to complete/improve:
In continuation of our pilot exercise during the first IC round, it has been also decided that for the pilot exercise it was not necessary to organise this work within the already existing Geographical Intercalibration Groups (GIG's). However, it seemed relevant to make regional groups that were responsible for the exchange of data and the reporting of the results. The main difference being that the process is centrally guided and that all data are submitted to the central database to facilitate comparisons between the national methods and the common metrics.
In the same way, we decided to use both the options 2 (common metrics approach) and 3 (direct national classification comparison within regional groups). The option 2 is used at the European level, at least to ensure the comparability of reference conditions between countries and regions.
26 Participants / Member States are involved:
Austria, Belgium-Wallonia, Belgium-Flanders, Czech Republic, Denmark, England-Wales, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Latvia, LLithuania, Luxemburg, Netherlands, Northern Ireland, Norway, Portugal, Romania, Scotland, Slovakia, Slovenia, Spain, Sweden
A common database is organized at the European level including environmental description of sites, pressures descriptions and biological information (species abundance and individual fish length).
Reference sites are selected using both common criteria at the European scale (sites not or slightly locally impacted) and national criteria. Sensitivity of the different national methods and common metrics to human pressure intensity is examined.

Estimated timetable for the completion of the work:

January-April 2009: Data collection / Data checking. Common database
May 2009: Preliminary analysis (common metrics and regional groups)
May 27-28 2009: 6th IC Meeting. Ireland. First results and discussion.
Harmonisation of statistical methods
Table of contents of the final report
June-August: Data analysis. Exchange between partners. Final results.

September 2009: Report to ECOSTAT

October 2009: ECOSTAT Meeting. Recommendations.

October 2009: 7th Fish IC meeting. Results and discussion about H/G and G/M classes boundaries

Beginning 2010: 8th Fish IC meeting. Slovakia. Discussion about H/G and G/M classes boundaries

October 2010: Final report: methodology, results, boundaries between class 1/2/3
Questions, & environmental situations remaining open.

Future tasks 2010-2011: Large rivers,…

Comments: --

2: Methods to be intercalibrated (Regional group reports)

Regional group reports have been sent by their respective regional coordinators (see list before)

A. Nordic Group

The Nordic Group involves Finland, Ireland, Northern-Ireland, Norway, Scotland, and Sweden. Co-ordinator country in the group is Finland.

The group has two national methods to compare: the Finnish (FiFi) and Swedish (VIX) fish indexes.

Methods to be intercalibrated

Overview of the Finnish Fish Index (FiFi)

The Finnish Fish Index (FiFi) is currently published in Finnish and submitted as a manuscript to an international journal (Vehanen *et al*.: Environmental assessment of boreal rivers using fish data – A contribution to the Water Framework Directive. *Fisheries Management and Ecology*, submitted). The Finnish report can be downloaded from the web-pages of the Finnish Fisheries Research Institute: www.rktl.fi/?view=publications&cat=41 . The report is "Vehanen, T., Sutela, T. & Korhonen, H. 2006. Kalayhteisöt jokien ekologisen tilan seurannassa ja arvioinnissa. Alustavan luokittelujärjestelmän perusteet. Kala- ja riistaraportteja nro 398."

FIFI index is a multimetric index based on the reference conditions approach. Fish data is collected from wadeable rapids and stream areas that are electrofished according to the electrofishing CEN-standard (Water quality – Sampling of fish with electricity, EN 14011). Currently only the results of the catch of the first run is used by the index

Altogether 13 fish-based candidate metrics from biological elements (fish abundance, species composition and age structure) defined by the WFD were tested. First we used the discriminant function analysis (DCA) to classify the reference (unimpacted) sites and impacted sites into their original groups. The proportion of observations that were not reassigned to their original group (an apparent error rate, APER) was used as a measure of the effectiveness of the metrics to distinguish between the impacted and unimpacted sites. Those candidate metrics with a small APER were selected for further analysis. They were correlated (Pearson) against the magnitude of human alteration to reveal the shape of response and that they showed a consistent trend throughout the scale of alterations (Fig. 1). Finally correlations between the selected metrics were examined, and if high correlations existed, one was removed to avoid including several metrics reflecting the same pressure.

According to the results five metrics were selected for the fish index: number of fish species, proportion of intolerant species, proportion of tolerant species, density of cyprinid individuals, and density of age-0+ salmonids individuals.

Cumulative frequency distributions (CFD) were used to characterise the distribution of candidate metrics (Fig. 2). The value of the metrics for each finding was calculated by dividing the total number of findings that were smaller than the finding by the total number of all the values. This means that the metrics value for each finding was a point estimate for classical probability to have a smaller finding than the current one. The CFD was forced to start from zero, and it reached value one either at the maximum (density of 0+ salmonids and Cyprinidae family and number of species) or at the 95th percentile (proportion of tolerant and intolerant species). For metrics that increased with human disturbance (proportion of tolerant species, density of Cyprinidae group) the CFD scale was reversed (1-value) (Fig. 2). The number of fish species was an exceptional variable because the response to disturbance was hump-shaped: the species number increased with the disturbance effect, but declined again in the heavily impacted sites. Therefore it is necessary to calculate different values for these highly impacted sites (human alteration >11, Fig. 2). We used subjective valuation for highly disturbed sites following the shape of response (Fig. 1). For sites with less human alteration (< 11) we used a point estimate for classical probability (Fig. 2).

The fish index value was calculated as a mean from the five-point estimated metrics values for each site. The median index value for the reference sites of each river type was used as reference. The index values were calculated to ecological quality ratios (EQR) by dividing the index value for each site by type specific reference value. By the definitions of the WFD, ecological status classes must be set at high, good, moderate, poor and bad. The boundary between a high and good ecological status was set at the 25th percentile of the reference site EQRs. This was done because there is also natural variation in the reference areas and a sampling error of –25% as estimated to be outside the high status. The boundaries for other ecological status classes were set in equal intervals towards 0, the theoretical minimum.

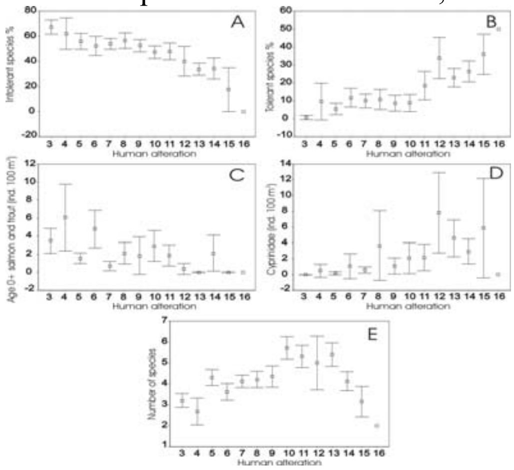


Figure 1. Responses of the selected metrics to human pressure.

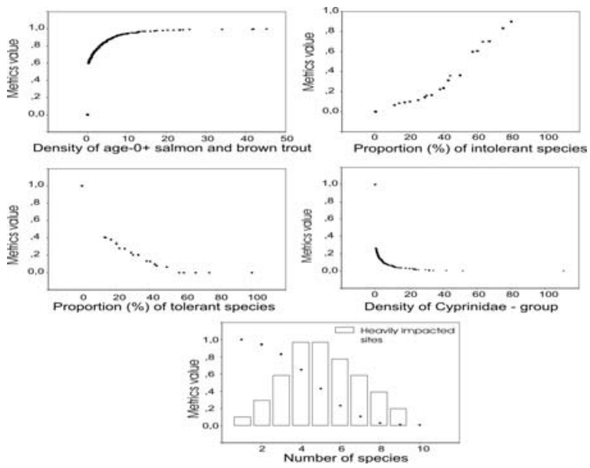


Figure 2. Cumulative frequency distributions for the five metrics selected for the fish index and calculated from the electrofishing data of the reference river sites and used to determine the value (between 0–1) for each fish metrics.

Overview of the Swedish method (VIX)

An index for classification of ecological status based on fish data from running waters was developed in Sweden in 2006. The report "Environmental quality criteria to determine the status of fish in running waters - development and application of VIX" (Beier et al. 2007) is published at www.vattenportalen.se and www.fiskeriverket.se (see "Service / Publikationer / Finfo").

To apply VIX (VattendragsIndeX = running water index) standardised data from electric fishing are needed. Fish data is collected from wadeable rapids and stream areas that are electrofished according to the electrofishing CEN-standard (Water quality – Sampling of fish with electricity, EN 14011). In Sweden, the period of sampling is restricted to July-October to be able to catch YOY fish and to avoid periods with flooding, and only native species have been considered when calculating the index.

Abundances are based on estimations from one or more runs of electric fishing, i.e. all electrofishing runs are included to calculate the metrics. Environmental variables needed are 1) size class of catchment upstream of the sampling site, 2) class of proportion of lake area in the catchment, 3) least distance to the closest lake upstream or downstream the sampling site (up to 10 km), 4) altitude above sea level, 5) slope, 6) yearly average air temperature, 7) average air temperature during July, 8) wetted width of the stream and 9) sampled area. Additionally, migration type of the trout (resident, lake migrating or sea migrating) is used to adjust the index accordingly.

The main principles and statistical procedures for developing the EFI (European Fish Index) were applied for developing VIX. Reference sites were identified using maximum values (1 or 2 out of 5) of four impact categories (toxic or acidification impact, nutrient or organic input, morphological as well as hydromorphological impact). Theoretical expected values for each metric are calculated using multivariate regression incorporating relevant environmental variables (transformed values). The residuals between expected values and observed values are transformed in two steps. First, the residuals are transformed to Z-values by dividing the residual with the standard deviation of the residuals for each metric. The Z-values are transformed to P-values, which are probabilities for the observed value to represent impacted conditions, adjusted for the direction of the expected change in the metric with increased impact (the lower the P-value, the higher probability that the site is impacted). The index consists of the mean of these P-values.

The main focus was to find the clearest possible separation between "impacted" and mainly "unimpacted" sites, i.e. the "GM" border between good and moderate status (class 2 and 3 out of 5) according to the Water Framework Directive. According to the methods used developing the EFI, the border between good and moderate status was chosen where the probabilities of making type-I and type-II errors were equal, i.e. where the risks of classifying an impacted site (preclassified impact 3-5) as unimpacted (preclassified impact 1-2), or vice versa, were equal. The border between high and good status ("HG") was chosen so that the probability of classifying an unimpacted site (preclassified impact 1-2) as impacted (preclassified impact 3-5) was less than 5%. The border between poor and bad ("PB") was chosen so that the probability of classifying an impacted site (preclassified impact 3-5) as unimpacted (preclassified impact 1-2) was less than 10%. The border between moderate and poor was set in the middle between the GM and PB borders. The borders for status classes, set according to the Swedish dataset used for developing VIX, of the index values are: class 1 (high) ≥0.749, class 2 (good) ≥0.467, class 3 (moderate) ≥0.274, class 4 (poor) ≥0.081, and class 5 (bad) <0.081.

Potential metrics during the index development were the metrics from the existing Swedish index for fish in streams (FIX), metrics from another index especially developed for salmonid coastal streams (HÖL) and metrics from the European Fish Index (EFI). Six metrics out of 24 potential metrics remain in the final index (VIX) which distinguishes the degree of general human impact. The VIX metrics are 1) abundance of salmon and trout, 2) proportion of salmonid species reproducing, 3) proportion of tolerant species, 4) proportion of intolerant species, 5) proportion of lithophilic individuals and 6) proportion of tolerant individuals. The metrics 3-5 are also used in the EFI, but then only incorporating data from the first run of electric fishing.

VIX could classify 66% of the Swedish sites correctly, in the dataset used for the index development, when comparing with preclassified impact. When applying the index on an independent dataset containing preclassified impact, 73% of the sites were correctly classified as either belonging to the preclassified impact groups 'unimpacted' (class 1-2) or 'impacted' (class 3-5). In the Swedish electric fishing data (August 2006), 50% of the sampling sites were classified to good status, and 23% to moderate status, i.e. the majority of sites were in the crucial interval of good and moderate status. There was a significant positive relationship between EFI and VIX. However, EFI estimated the status class higher compared to VIX approximately eight times more often than the reverse case. Especially small streams with sea migrating trout were estimated comparatively higher with EFI than with VIX.

Checking of compliance of national assessment methods with the WFD requirements

Compliance of the Finnish Fish Index (FiFi) to WFD

The monitoring method for the parameters of the FiFi-index conforms to the international standards (CEN-standard, Water quality – Sampling of fish with electricity, EN 14011).

In compliance with the WFD the FiFi index is a type specific approach. Within the ecoregion (Fenno-Scandian shield) the national typology is used. This typology is based on geology and size of catchments and includes 11 river types. In addition, northern rivers above the tree limit (partly Borealic Uplands) are separated. Type-specific biological fish-based reference conditions are established from the reference sites. Within the index the five variables represent the values of the quality elements for the classification of ecological status of rivers specified in Annex V of the WFD: composition (proportion of tolerant and intolerant fish species), abundance (density of Cyprinid-group, number of fish species) and age structure (density of age 0+-salmonids) of fish fauna.

Hydromorphological elements, chemical and physico-chemical elements and specific pollutants are taken into account when selecting the reference sites. Only sites with no or low amount of pressures can be selected for reference sites. This is done in accordance with the common metrics – intercalibration and guidance (Guidance on the Intercalibration process-Phase 2, Annex II: Guidance for deriving reference conditions). The impact of human pressures on metrics used to build the index was revealed during the development of the index (see the description of index above).

The results are calculated and expressed as ecological quality ratios for the classification of ecological status. The ratio is expressed as a numerical value between zero and one, with high ecological status represented by values close to one and bad ecological status by values close to zero.

Definitions for ecological status in rivers for the fish fauna as biological element follow the definitions of the WFD: high, good moderate, poor and bad. High status is defined by the reference data so that 25% of the reference sites (lowest quartile of the index values) remain outside of high status. Rest of the status classes are set in equal intervals towards zero. This is in accordance with the guidance, and also with the normative definitions. Normative definitions state that that in high status species composition and abundance correspond totally or nearly totally to undisturbed conditions, and in high status there are slight changes in species composition and abundance from the type-specific communities.

Compliance of the Swedish Index (VIX) to WFD

The monitoring method for the parameters of the VIX-index conforms to the international standards (CEN-standard, Water quality – Sampling of fish with electricity, EN 14011).

The VIX index is a site based approach. The reference values are calculated unique for each site by using the whole group of selected reference sites, i.e. including both impacted and unimpacted sites. Class boundaries are set originally based on the Swedish dataset used for developing VIX, with the main focus on the border between good and moderate status. Within the index the six metrics represent the values of the quality elements for the classification of ecological status of rivers specified in Annex V of the WFD: composition (proportion of tolerant and intolerant fish species, proportion of tolerant individuals, proportion of lithophilic individuals), abundance (number of fish species, abundance of salmonids) and age structure (proportion of salmonids reproducing) of fish fauna.

Similar principles and statistical procedures for developing the European Fish Index EFI (FAME consortium 2004, Pont et al. 2006) were applied for developing VIX. Reference sites were identified using maximum values (class 1 or 2 out of 5) of four impact categories (preclassified toxic or acidification impact, nutrient or organic input, morphological as well as hydromorphological impact). This is done in accordance with the common metrics – intercalibration and guidance (Guidance on the Intercalibration process- Phase 2, Annex II: Guidance for deriving reference conditions). The impact of human pressures on metrics used to build the index was revealed during the development of the index (see the description of index above).

The results are calculated and expressed as ecological quality ratios for the classification of ecological status. The ratio is expressed as a numerical value between zero and one, with high ecological status represented by values close to one and bad ecological status by values close to zero.

Definitions for ecological status in rivers for the fish fauna as biological element follow the definitions of the WFD: high, good moderate, poor and bad. The border between good and moderate status is set first, the clearest separation between impacted and unimpacted sites is 0,467. High status is defined by the reference data as the proportion of classifying an unimpacted site as impacted is less than 5% (0,749). Rest of the status classes are set in intervals towards zero. This is in accordance with the guidance, and also with the normative definitions. Normative definitions state that that in high status species composition and abundance correspond totally or nearly totally to undisturbed conditions, and in high status there are slight changes in species composition and abundance from the type-specific communities.

Progress on feasibility checking: method acceptance criteria

The Nordic Group tested different river typology options using altitude (4 classes), geology (3 classes) and catchment size (5 classes) as variables. The general result was that typology (in all cases) improved the comparison of the results between the two methods compared. Reference conditions in different river types may differ and comparing similar river types improved their comparability. Currently the simple typology including geology and altitude (nine river types) is used by the group.

In terms of typology the two classification methods, FiFi and VIX, differ in nature. While the FiFi- index is a strict type based method using reference conditions for each river type separately, VIX calculates the reference conditions by using the whole group of reference sites, i.e. including all types, as a reference. Therefore the typology is used in the Nordic Group comparisons only by removing sites from those types that are overrepresented in reference group in VIX calculations. Direct comparisons between types cannot be made, and therefore the use of typology is partly unfeasible.

If the methods shall be used in other countries, some adjustments are probably needed. For VIX it is important to investigate whether or not the reference values agree for the conditions in these countries. These calculations can be done. However, the critical point in the system is how to decide impact on a five degree scale. The classification system today is partly based on experiences and expert judgement. A revision of the classification system can probably improve both indexes even though they seem to work quite good already.
Still, there is a problem to apply the indexes. The indexes are built to use on a group of sites, not to study one site at one test-fishing occasion. When applying the index on one site, about three times out of ten the classification is incorrect. If the risk of misclassification is 30% for one sample, in the ideal case it declines to 0,027 after three samples (0,3^3). Therefore, to get a correct classification of a site several test-fishing occasions are needed. This issue can probably be illustrated by using sites were we can assume that the impact have been the same during the measuring period. Maybe we can agree on a proper sample size to be sure that the index probably is correct.

In terms of pressures the Nordic Group has agreed on how much pressures from different aspects (e.g. impoundment, acidification) is allowed in the reference sites. In general either no or low pressure is allowed in reference sites. This criterion follows the decisions made among the common intercalibration criteria for undisturbed sites.

The main pressures in the area covered by the group are pressures on water quality and morphology of rivers. Both indexes tend to respond to pressures similarly: there is a relatively high correlation (r = 0.713) between the indexes. This also holds when data from each countries is analyzed separately (r = 0.679-0.808), the only exception being Norway (r = 0. 228). There is also a response to pressures by both indexes on data on Norway, but the lack of correlation is mainly due to the fact that all Norwegian sites obtain high index values from both methods, and no low scoring sites are included. In terms of pressure the intercalibration between the both methods is feasible.

The basic assessment concept is the same in the both approaches: index is composed of several metrics which are found effective in response to human pressures. As the index values (or probabilities in VIX) increase the conditions should change towards reference conditions while the low values are indication of large changes. The basic difference in the concept is the setting of boundaries between the ecological status classes. The FiFi index assumes that most of the reference sites (75%, the good-high boundary is set here) are in high status, but makes no assumption of the shape of the distribution of index values in different river types. Rest of the status class borders are set in equal intervals towards zero value. VIX-index, however, assumes normal distribution of probabilities, and the border between good and moderate status is set where the probabilities of making type-I and type-II errors are equal, i.e. where the risks of classifying an impacted site as unimpacted are equal. The border between high and good status ("HG") is chosen so that the probability of classifying an unimpacted site as impacted is less than 5%.

Progress on collection of IC dataset and design the work for IC procedure

The collection of IC dataset has been completed. A data template together with instructions and description of the variables was sent to contact persons of the group in each country. Later, following a group meeting where the criteria for the reference sites was agreed, member countries was asked to revise the status of their reference sites.

Each country in the group has delivered fish data suitable for both indexes. The database of the group has 1651 sites, 159 from Finland, 493 from Ireland, 71 from Northern-Ireland, 152 from Scotland and 702 from Sweden. Out of 1651 sites, 264 reference sites are identified. Finland has classified 96, Ireland 31, Norway 21, Scotland 23 and Sweden 93 reference sites. Northern-Ireland has not distinguished reference sites from their fish data.

Progress on reference conditions/benchmarking

We used the Intercalibration method option 3 to compare the results of the FiFi and VIX – methods. First both national methods were applied to the dataset. Then we calculated normalised EQRs based on the national view. National values were then rescaled to a maximum of 1 and minimum of 0. Then we calculated the median value for the standardized reference dataset for both indexes and transformed the values into EQR's by dividing the standardized value by the median value. After this the median value of reference sites was 1 and the minimum value 0.

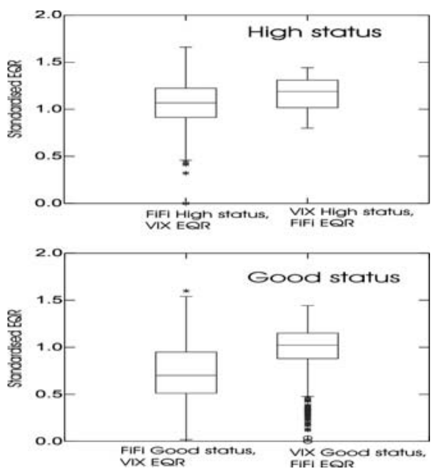


Figure 3. Box plot illustrating distribution of standardised EQR values for countries classified as being high status (above) or good status (below) in the FiFi and VIX indexes.

To determine whether there is a significant effect of country on the distribution of EQR values we followed the intercalibration guidance. All sites that were classified as high status by the Finnish system (FiFi) were selected, and for those sites the standardised EQR values from the Swedish system we extracted, and vice versa. We then used ANOVA test the possible differences. The difference between the countries was significant ($p<0.001$, Fig 3), as the EQR-values for both the VIX high status and good status sites were higher than in the FiFi system.

We plotted the distribution of standardised EQR values of the reference sites together with the boundaries for the high-good and good moderate sites (Fig. 4). FiFi index sets the boundary to the range of the 25% percentile of the EQR values of the reference sites (16-45%, variation is due to differences in river types). VIX-index is stricter and the high-good boundary leaves most of the reference sites (93%) outside the high status. The moderate-good status boundary in the FiFi system leaves only few reference sites to moderate status (2 %), whereas in VIX-system 21% of the reference sites achieve only moderate status.

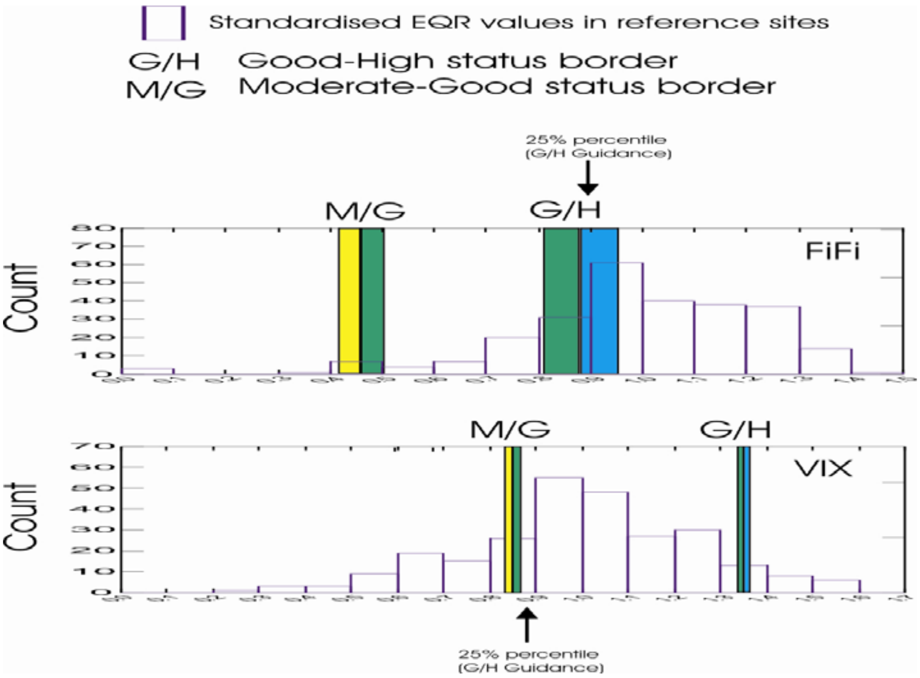


Fig. 4. Standardised EQR values for Fifi and VIX – indexes and the boundaries for good-high and moderate- good status classes.

B. Lowland-Midland Group

Overview of Member States providing national assessment methods

Do you have an overview of the national classification methods that will be intercalibrated? If not: when will this information be available?

Eleven partners from ten EU member states participate in the Lowland – Midland GIG, which is quite similar to the Central Baltic GIG. For Belgium, Flanders and Wallony participate separately. Sweden participates in the Northern GIG. Poland does not yet participate in the River Fish intercalibration. In total there are eight national methods with the following characteristics (for details see separate ZIP file)

Country	Method	Type of measurement	Number of metrics	Species presence	Species abundancy	Habitat guild	Trophic guild	Sensitivity guild	Reproductive guild	Fish region index	Migration index	Age structure
Belgium - Flanders	Upstream IBI	modelling; DFCRC	9	1	1	1	1		1	0	1	0
Belgium- Wallony	IBIP	DFCRC	6	1	1	1	0	1	1	0	0	1
Czech republic	CZ national method	0-group only; DFCRC	9	1	1	1	0	0	1	0	0	0
England - Wales	FCS	modelling; selected species; DFCRC	?	1	1	0	0	0	0	0	0	0
France	FBI	statistical method, deviation from reference conditions	7	1	1	1	1	1	0	0	0	0
Germany	FIBS	DFCRC	6 or 9	1	1	1	1	0	1	1	1	1
Netherlands	NL national method	DFCRC	5 to 8	1	1	1	0	0	0	0	1	0
Lithuania	LZI	DFCRC	≤ 12	1	1	1	1	1	1	0	1	0

DFCRC deviation from constructed reference community

Denmark, Latvia and Luxembourg have no national methods; the method from Estonia is not known

Checking of compliance of national assessment methods with the WFD requirements

*What are the arrangements in the GIG to verify the **compliance of national assessment methods** with the WFD requirements ? Has the GIG already started an evaluation of the compliance of national assessment methods with WFD requirements? Please give a short report on how this is done (or will be done)*

In a first step all members of the GIG agreed on a common set of environmental variables to characterise the river types and a common set of pressures, which are provided in the regional and common database. All MS agreed on the same reference criteria (pressures) as follows:
* All countries used the list of undisturbed sites in the common database which are also classified as reference sites by the concerned MS
* These sites have been checked for an appropriate fish community (> 30 individuals)
* All definite REFCOND sites of the Lowland – Midland groups will be used for EQR calculations

Common methods and boundary setting procedure are still in discussion within the Lowland Midland GIG

Steps in review of the compliance of national assessments methods with the WFD	Done?
Completeness of the method according to the WFD normative definitions	yes
Establishing of biological dataset	yes
Relationship between pressure and biological metrics	?
Setting reference conditions	yes
Setting high/good and good/moderate boundaries	no

Completeness of het national methods according to the WFD normative definitions	Species composition	Species abundance	Age structure
Belgium - Flanders	√	√	
Belgium- Wallony	√	√	√
Czech republic	√	partial (only YOY)	
England - Wales	selected species	selected species	
France	√	√	
Germany	√	√	√
Netherlands	√	√	
Lithuania	√	√	

Progress on Feasibility checking: method acceptance criteria

The intercalibration process ideally covers all national assessment methods within a Geographical Intercalibration Group. However, the comparison of dissimilar methods (“apples and oranges”) has to be avoided. Intercalibration exercise is focused on specific type / biological quality element / pressure combination. The intercalibration guidance foresees an “IC feasibility check” to narrow the actual intercalibration analysis to methods that address the same common type(s), the same anthropogenic pressure(s), and follow a similar assessment concept.

The task of the GIG is compilation of groups including similar assessment methods, and evaluation of “outlying” methods. A feasibility check includes coverage of **intercalibration types**, **pressures** and **method concept**. The aim of the check is to address if all national methods address the same common type(s) and pressure(s), and follow a similar assessment concept.

- *Has the GIG evaluated if intercalibration is feasible in terms of typology? . Are the common type delineations suited for the specific BQE intercalibration exercise? Are all assessment methods appropriate for the intercalibration water body types ? Are any types going to be added?*
-

Typology:
*The common intercalibration types for the Central-Baltic (CIT; see table below) have not been used to identify the type of river. This is because there is no agreement on this typology among MS. Instead every site is characterised by a set of environmental variables that are similar to those used for the CIT (except for alkalinity) as well as other variables. It is thus possible to link the CIT to these environmental variables, but this has not yet been done. All R-C1 to R-C6 are expected to be covered except for R-C5 (large rivers). The range over which the intercalibration is performed will be characterised by these environmental variables (see separate document for descriptive analysis)

Type	River characterisation	Catchment area (of stretch)	Altitude & geomorphology	Alkalinity (meq/l)
R-C1	*Small lowland siliceous sand*	10-100 km^2	lowland, dominated by sandy substrate (small particle size), 3-8m width (bankfull size)	> 0,4
R-C2	*Small lowland siliceous - rock*	10-100 km^2	lowland, rock material 3-8m width (bankfull size)	< 0,4
R-C3	*Small mid-altitude siliceous*	10-100 km^2	mid-altitude, rock (granite) - gravel substrate, 2-10m width (bankfull size)	< 0,4
R-C4	*Medium lowland mixed*	100-1000 km^2	lowland, sandy to gravel substrate, 8-25m width (bankfull size)	> 0,4
R-C5*	*Large lowland mixed*	1000-10000 km^2	lowland, barbel zone*, variation in velocity, max. altitude in catchment: 800m, >25m width (bankfull size)	> 0,4
R-C6	*Small, lowland, calcareous*	10-300 km^2	lowland, gravel substrate (limestone), width 3-10m (bankfull size)	> 2

*Every MS has indicated whether or not their national method can be applied to sites in other countries. Sites are included or excluded on environmental characteristics, fish species composition or data availability (methods differ in their data requirements). The result varies per country ranging from e.g. the method of England & Wales which cannot be applied elsewhere to the national method of Lithuania that had no restrictions. So not every national method is applicable everywhere, but the sum of the methods cover the Central-Baltic region up to 400 m altitude.

- *Has the GIG evaluated if intercalibration is feasible in terms of pressures?Do all national methods address the same pressure(s) ?*

Generally all methods have been developed in order to respond to single pressures or a combination of pressures, but there has been no approaches to develop one-to-one relationships between methods or metrics and single pressures. An in-depth analysis to which pressures national methods address has not yet been performed. The only metric that can be considered to have a direct link to a certain type of pressure is the migration guild that responds to disruptions in connectivity.

Within the River Fish intercalibration cross-GIG first the most important pressures that alter fish communities have been identified. Data on these pressures are available for every site. To deliver these data is compulsory. It is thus possible to demonstrate the response of national methods to various pressures or combinations of pressures.

As the national methods differ they may not address the same pressures. This cannot be indicated on beforehand, but may become clear during the intercalibration exercise.

See 2.1 for details on the national methods.

- *Has the GIG evaluated if intercalibration is feasible in terms of assessment concept? Do all national methods follow a similar assessment concept? If the GIG previously encountered problems with regard to checking comparability of dissimilar methods, how are these resolved ?*

The national methods differ in their assessment concept. The pilot exercise with a selection of methods concluded that intercalibration may be feasible (Jepsen & Pont 2007). Since there are several methods and in addition there are also common metrics resulting from the projects FAME and EFI+ it is assumed that the intercalibration exercise will be able to identify which methods respond well or not to pressures and where boundaries require adjustment (see separate document with preliminary analysis according to option 3).

C. Alpine-type Mountains Group

Overview of Member States providing national assessment methods

Do you have an overview of the national classification methods that will be intercalibrated? If not: when will this information be available?

Overview of all three national classification methods within the Alpine GIG (for details see Annex I):

	country	Austria	Germany	France
	method	FIA	FIBS	FBI
	type of measurement	deviation from constructed reference community	deviation from constructed reference community	statistical method, deviation from reference conditions
	number of metrics	9	6	7
metrics include	**species presence**	+	+	+
	species abundance	+	+	+
	habitat guilds	+	+	+
	thropic guilds		+	+
	sensitiv guilds			+
	reproductive guilds	+	+	+
	fish region index	+	+	+
	migration index		+	
	age structure		+	

* Slovenia and Spain have no national methods until now

Checking of compliance of national assessment methods with the WFD requirements

What are the arrangements in the GIG to verify the ***compliance of national assessment methods*** *with the WFD requirements ? Has the GIG already started an evaluation of the* *compliance of national assessment methods with WFD requirements? Please give a short report on how this is done (or will be done)*

steps in review of the compliance of national assessment methods with the WFD	**done**
completeness of the method according to the WFD normative definitions	**yes**
establishing of biological dataset	**yes**
relationship between pressure and biological metrics	**yes**
setting of reference condition	**yes**
setting of high/good and good/moderate boundaries	**no**

Completeness of the national methods of the WFD normative definitions

method	**species composition**	**species abundance**	**age structure**
FIA	+	+	+
FIBS	+	+	+
FBI	+	+	

In a first step all members of the GIG agreed on a common set of pressures and metrics which are provided in the national & common database. All MS agreed on the same reference criteria (pressures) as follows:

- All countries used the list of undisturbed sites in the common database which are also classified as reference sites by the MS.
- Theses sites have been checked for an appropriate fish community (> 30 individuals, single species sites are accepted)
- The impact of possible additional pressures (especially stocking/angling) on these sites has been checked by the MS – impacted sites were excluded
- All definite Reference condition sites of the alpine group will be used for EQR calculations

Common methods and boundary setting procedure are still in discussion within the GIG.

Progress on Feasibility checking: method acceptance criteria

The intercalibration process ideally covers all national assessment methods within a Geographical Intercalibration Group. However, the comparison of dissimilar methods (“apples and oranges”) has to be avoided. Intercalibration exercise is focused on specific type / biological quality element / pressure combination. The intercalibration guidance foresees an “IC feasibility check” to narrow the actual intercalibration analysis to methods that address the same common type(s), the same anthropogenic pressure(s), and follow a similar assessment concept.

The task of the GIG is compilation of groups including similar assessment methods, and evaluation of “outlying” methods. A feasibility check includes coverage of **intercalibration types**, **pressures** and **method concept**. The aim of the check is to address if all national methods address the same common type(s) and pressure(s), and follow a similar assessment concept.

- *Has the GIG evaluated if intercalibration is feasible in terms of typology? . Are the common type delineations suited for the specific BQE intercalibration exercise?*

Are all assessment methods appropriate for the intercalibration water body types ? Are any types going to be added?

Fish-based river assessment with fibs and FIA is based on reconstructed reference fish communities taking into account a defined set of riverine species from Germany and Austria. Each reference fish community reflects unimpacted river conditions by taking into account river type as well as zoogeographical aspects and the longitudinal river zonation.

- Thus, fibs and FIA principally are applicable in any thinkable river type with a natural fish composition covered by the defined set of German and Austrian riverine species.
- Some limitations exist in river types of other countries housing species which do not belong to the defined set of German riverine species and which can not be replaced by an ecological equivalent of the set.

- *Has the GIG evaluated if intercalibration is feasible in terms of pressures?Do all national methods address the same pressure(s) ?*

All methods (FIA, fiBS, FBI) address the same pressures (see chapter 2.2)

- fiBS and FIA- in accordance to the WFD - principally react on any pressure or combination of pressures leading to significant alterations of species composition and/or species abundance and/or age structure, such as
  - impairment of river habitats,
  - impairment of river structure and river morphology
  - impairment of hydrology
  - impairment of fish migration
  - impairment of substrate quality
  - impairment of water quality

- *Has the GIG evaluated if intercalibration is feasible in terms of assessment concept? Do all national methods follow a similar assessment concept? If the GIG previously encountered problems with regard to checking comparability of dissimilar methods, how are these resolved ?*

FIA and fiBS follow a similar assessment concept (see chapter 2.1 and Annex I)
FBI follows a dissimilar approach (model based approach, see chapter 2.1)
Although it is not possible to include the Danube fish community into the FBI, the reference fish communities for the alpine French rivers were classified according to the requirements of the FIA and fibs, providing comparability between the FBI and the FIA & fiBS.

D. Mediterranean South-Atlantic

Comment on the current status of National Methods development

Among the MS that are included in the Mediterranean and South Atlantic Regional group, only one (France) has an official National River Bioassessment Method based on fish communities available for the current intercalibration phase. Therefore it was not possible to undertake any intercalibration exercise among National Bioassessment Methods of the MS included in this regional group.

Nevertheless, both Portugal and Spain are currently developing National Fish Indexes. However, since the methods are not yet completed and official, it is still not possible to provide a full description of the methods.

The Portuguese National Bioassessment Method based on river fish communities is on a final stage. It is a multimetric approach based on guild metrics. It is expected that until the end of 2009 a first version will be available to be tested at a national level and for intercalibration purposes. The Portuguese National Method is based on an official sampling method that follows the *CEN Norm* (EN14011, Water quality – Sampling of fish with electricity, 2003).

The Spanish Fish Index is also being finalised. It consists of a predictive modelling approach based on species composition of fish communities. Nevertheless, it cannot yet be considered the Spanish official Index to be used on the bioassessment of the ecological status of rivers, since it is still on the validation stage. This stage will consist on the comparison of the results obtained with this index and those of other methods such as EFI+ and IBICAT. The Index will be official after its approval both by an expert committee and by Ministry officials.

Greece has no plan for the development of a National River Bioassessment Method based on fish communities for now.

France will employ the same bioassessment method used in the previous intercalibration exercise, the *Fish-based Index* (FBI). It is a method based on deviations from expected values under reference conditions, using a predictive modelling approach. It uses metrics based on individual indicator species. The method is described with further detail in the *Lowland* or *Alpine Regional Group* sections of the present report. Even though the Index is currently being revised, the new version will not be available before the end of the present intercalibration phase.

E. Danubian Group

The Danubian GIG consists of six member states: Austria, Bulgaria, Czech Republic, Hungary, Romania and Slovakia. Austria and Czech Republic are also members of other GiG (Alpine and Midland/Lowland, respectively). All MS of the Danubian GIG have declared their interest to continue their participation at the IC process. On the other hand, the progress in the IC exercise achieved by now, and the intensity of participation may vary from country to country. Participation of Austria, Czech Republic, Romania and Slovakia has resulted in delivering data to the common database, but also in active collaboration in 2009. On the other hand, participation of Hungary became irregular over the last year, and the participation of Bulgaria has been rather passive by now. Nevertheless, we are hoping that both of the latter MS will fully participate at the subsequent IC process.

Methods to be intercalibrated

Overview of Member States providing national assessment methods
From among the six member states of the Danubian GIG (Austria, Bulgaria, Czech Republic, Hungary, Romania and Slovakia), only Austria, Czech Republic and Slovakia have developed their national methods. Romania will use the EFI+ method, Hungary and Bulgaria appear to be in the process of developing their national methods, though no details are available at the moment, and it is not clear when the methods are completed. The description of the Austrian method is provided within the Alpine GIG section, therefore, the following text focuses on methods of two member states: Czech Republic and Slovakia.

The Czech method
General principles
The Czech method (CZM) is based on the assessment of young-of-the-year (YOY) fish exclusively, using a multimetric Czech Index (CZI). YOY of European freshwater fishes occupy species-specific habitats reflecting their life-history requirements (Kryzhanovsky, 1949). Accordingly, YOY sampling has been proved as a tool that defines the availability of spawning/nursery habitats at a site (Oberdorff and Hughes 1991; Copp, 1992), as well as ecological function and integrity of riverine systems (e.g. Copp, 1989b; 1992; Oberdorff et al., 1993; Garner, 1995; Schiemer et al., 2003). YOY sampling provides a proper response to population dynamics, since year class strength is mainly affected by events that occur in the fishes' early life (Balon, 1984). Thus, existence of a suitable spawning/nursery habitat and the availability of food could be of the utmost importance (Lightfoot and Jones, 1996, Garner, 1996). YOY are also easier to collect in large rivers than adult fish, and therefore are thought to better estimate the actual fish assemblage structure at specific sites (Cattanéo, 2005). Evaluation of the ecological status of streams based on fishes using CZM requires a proper typology of streams, reference communities for each stream type, and four metrics to calculate CZI (see below).

Sampling
The sampling procedure used in CZM is based on electrofishing. Partial sampling of the streams is sufficient, however, all types of habitats must be covered to obtain a representative sample of the site. Sampling area borders are determined with help of the portable GPS receiver. All sampling occasions should be undertaken during late summer, to assure efficiency of YOY sampling (Copp, 1989a). Electrofishing of YOY is conducted by wading the bank in an upstream direction, regardless the river size (electroshocker maximum output 225 - 300 V, 6 A, pulsed D.C.). Although point abundance and continuous sampling of YOY are comparable in terms of qualitative analyses, continuous sampling is preferred in order to allow quantitative interpretation of results (Janáč and Jurajda, 2007). Most fish are identified to species and immediately released at the site of capture. Specimens that cannot be reliably identified are fixed in 4% formaldehyde solution for laboratory identification. YOY sampling represents a useful method for assessing the ecological quality of rivers with several advantages compared to sampling the whole fish assemblages: 1) it provides a sensitive response to the habitat structure; 2) this response is relatively fast and reliable, regardless the longevity of adult fish assemblages or stocking; and 3) sampling efficiency in the longitudinal

gradient is of negligible importance, since YOY gather in shallow areas near the shoreline (Schlosser, 1987) where they can be easily sampled regardless the river size.

Stream typology

The river typology of the Czech Republic was recently modified by the team of Jakub Langhammer and the following text, which contains his results, is presented with his kind permission. As a first step, appropriate variables that describe natural variability of rivers were preselected. These variables were a subject of statistical analyses, such as Agglomerative hierarchical clustering (AHC), Pearson correlations, etc., performed on the base of GIS data covering the whole country. The analyses defined groups (clusters) of highly correlated indices. A variable with the highest explanatory power and/or relevancy to the variability of the biota was selected from each group. Thus, four final variables were chosen: sea drainage area, altitude, geology and stream order according to Strahler (1952). From among these, the sea drainage area was selected as a substitute of ecoregion. The ecoregion boundaries almost overlap with the sea drainage, however there are still some inaccuracies in their definition. Since the natural boundaries of sea drainage area better reflect the differences in species composition, natural boundaries are used rather than the artificial ones.

Based on the above approach, streams in the Czech Republic were divided into 23 main river types with further subdivision in the 55 river types on the fine-scale. This general typology was further modified with regard to the evaluation of fish assemblages. Subsequent cluster analyses divided the streams in Czech Republic into the following 5 main fish river types: 1) large rivers of the North Sea drainage area (Elbe River catchment) ; 2) large rivers of the Black Sea drainage area (Danube River catchment); 3) medium rivers of the Black Sea drainage area (Danube River catchment); 4) medium to large rivers of lower altitudes without sea drainage area specification; 5) brooks to medium rivers of predominantly higher altitudes without sea drainage area specification.

Geology was not found to have significant effect on the fish assemblage, and thus, geology was omitted as the variable for river typology according to fish. Altitude and stream order were found to be appropriate predictors of such variables as abundance or ecological guilds composition, and were used for further division of river types on the fine scale. Further subdivision of main river types resulted in the following 13 fish river types in the Czech Republic:

1	large rivers of the North Sea drainage area (Elbe River catchment)
2	large rivers of the Black Sea drainage area (Danube River catchment)
3	medium rivers of the Black Sea drainage area (Danube River catchment)
	Medium to large rivers of lower altitudes without sea drainage specification:
4	altitude less than 200 m and stream order from 4 to 6
5	altitude less than 200 m and stream order from 7 to 9
6	altitude from 200 to 500 m and stream order from 4 to 6
7	altitude from 200 to 500 m and stream order from 7 to 9
	Brooks to medium rivers of predominantly higher altitudes without sea drainage specification:
8	altitude less than 200 m and stream order from 1 to 3
9	altitude from 200 to 500 m and stream order from 1 to 3
10	altitude from 500 to 800 m and stream order from 1 to 3
11	altitude from 500 to 800 m and stream order from 4 to 6
12	altitude greater than 800 m and stream order from 1 to 3
13	altitude greater than 800 m and stream order from 4 to 6

In conclusion, the river typology of Czech Republic according to fish is based on three variables: sea drainage area, altitude and stream order. Five main river types corresponding to typical assemblages are further divided by altitude and stream order resulting in the final 13 fish river types.

Czech multimetric index (CZI)

A typical fish assemblage was reconstructed for each of the 13 river types. For this purpose, a procedure based on the combination of present data, available historical data and expert judgment was used. Expected reference assemblages were subsequently expressed as values of various metrics that were preselected based on their ecological relevance and presumed ability to detect assemblage degradation. The preselected metrics were: presence of typical species, number of all species, overall abundance, presence of particular habitat and reproduction guilds, number of species belonging to particular habitat and reproduction guilds and relative abundance of particular habitat and reproduction guilds. In order to detect the deviations from the reference conditions, all the metrics were expressed as the ecological quality ratio (EQR) between observed and expected values. The final metrics selection was done according to their ability to distinguish between reference and disturbed sites from the national monitoring programme. This led to the selection of following metrics:

1. presence of typical species ($F_{1, 235} = 5.31$; $P < 0.0221$; Tukey: $P < 0.0221$; Fig 1a)
2. overall abundance ($F_{1, 249} = 3.99$; $P < 0.0469$; Tukey: $P < 0.0469$; Fig 1b)
3. relative abundance of rheophilous species ($F_{1, 277} = 13.71$; $P < 0.0003$; Tukey: $P < 0.0003$; Fig 1c)
4. relative abundance of eurytopic species ($F_{1, 286} = 32.26$; $P < 0.0001$; Tukey: $P < 0.0001$; Fig 1d).

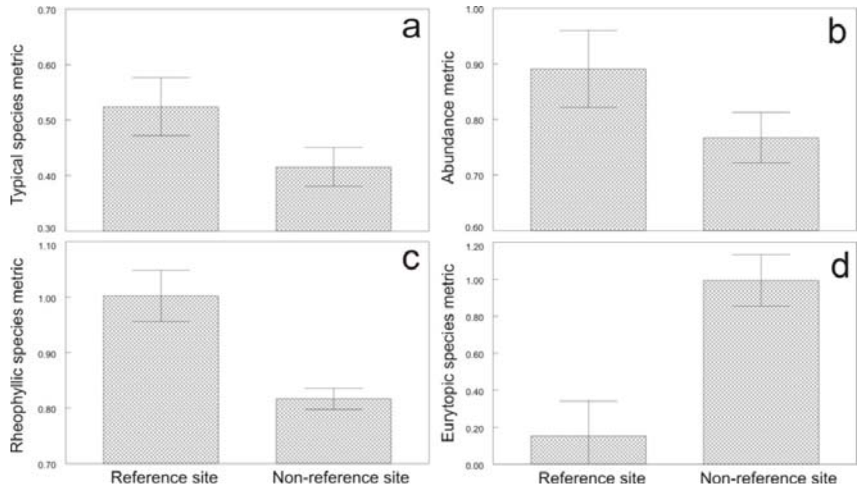


Fig. 1: Typical species (a), abundance (b), rheophilous species (c) and eurytopic species (d) metrics values on reference and non-reference sites. Values are adjusted means ± S.E.

The Czech multimetric index consists of these selected metrics and is expressed as follows:

$$CZI = \frac{(T_S + A + R_S) - (E_S)}{4}$$

where T_S = EQR of presence of typical species, A = EQR of overall abundance, R_S = EQR of relative abundance of rheophilous species, and E_S = EQR of relative abundance of eurytopic species.

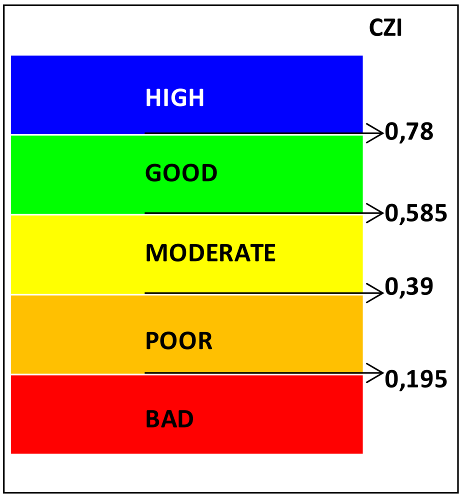
Due to low natural abundance in the altitudes higher than 800 m, it is not possible to distinguish between such reference and non-reference sites using the overall abundance metric. Thus, for altitudes higher than 800 m the CZI is modified as follows:

$$CZI = \frac{(T_S + R_S) - (E_S)}{3}$$

The relative abundance of rheophilous species is considered a metric that increases ecological status of streams. However, chub *Leucisus cephalus* (L.) is a rheophilous species that is generally more resistant to several pressures than the other members of the rheophilous guild. Thus, an assemblage dominated by chub could achieve a high value of R_S despite the fact that it does not necessarily reflect the good status of the stream. In order to handle this situation, the value of R_S is considerd equal to zero when chub is the only rheophilous species in the assemblage.

Class boundaries

Class boundaries within CZM were set with the help of the CZI values achieved on the reference sites according to the option C for setting class boundaries (Guidance document n. 10). The boundary between class 1 and 2 was set as the 1st quartile (25%) of distribution of reference sites. The remaining boundaries were set in equal distances according to it. The final class boundaries are:



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The Slovak method

General principles

The Slovak method (SKM) is based on a multimetric index called Fish Index of Slovakia (FIS). SKM uses a new typology of Slovak streams designed especially with regard to fish communities (see below). For each stream type, a hypothetical reference fish community has been defined as a surrogate of large datasets necessary for valid statistical analyses. Such a reference community provides the expected values necessary for calculation of FIS that is based on the evaluation of observed *vs.* expected values. This evaluation is executed through nine metrics developed with regard to specific conditions in Slovakia. Most of the metrics follow the classification of fishes into ecological guilds. To facilitate calculation of FIS, a software tool FIScalc1.1. that works within the Microsoft Excel package has been developed. To reduce uncertainties in the evaluation of the ecological status of streams in Slovakia as much as possible, parallel to FIS, the European Fish Index plus (EFI+) will also be calculated, and the results from both methods will be assessed.

Sampling

The sampling procedure used in SKM is based on electrofishing. Whole sampling of the streams is preferred, though this is not always possible in medium and/or large rivers, where partial sampling is applied. In such a case, all types of habitats must be covered to obtain a representative sample of the site. In order to ensure collection of YOY specimens, and with regard to climatic conditions in Slovakia, the sampling campaign occurs between 16 July and 30 November, depending on the region, where the monitored stream is situated (local climatic conditions differ considerably in Slovakia). Most fish are identified to species and immediately released at the site of capture. Specimens that cannot be reliably identified are fixed in 4% formaldehyde solution for laboratory identification. The details on the sampling protocol required by SKM have been described elsewhere (Hensel, 2002; Mužík, 2007). In general, this protocol is fully compliant with the sampling procedures required by the EFI+ process (http://efi-plus.boku.ac.at).

Stream typology

The typology of Slovak streams reflecting the fish communities has been developed based on two main criteria: the zoogeographical structure of fish fauna in Slovakia, and the zonation of streams. All details including justification of such approach have been described by Hensel (2001). This new typology used in SKM contains 23 stream types (Fig. 2).

Atlantic province	Poprad district	montane	> 800 m a.s.l.	horný tok Poprad a prítoky Popradu a Dunajca nad 800 a.s.l.	1
		submontane zone	< 800 m a.s.l.	stredný tok Popradu, ako aj Dunajec a ich prítoky do 800 a.s.l.	2
			< 500 m a.s.l.	spodný tok Popradu po sútok s Valaskou vodou do 500 a.s.l.	3
[illegible] province	Upper transition district	montane	> 800 m a.s.l.	pramene a prítoky Váhu nad 800 a.s.l.	4
		submontane zone	< 800 m a.s.l.	prítoky Váhu do 800 a.s.l.	5
				horný tok Váhu po sútok s Oravou	6
	Potiský district	montane	> 400/500/600 m a.s.l.	Laborec, Topľa a Ondava nad 400, Slaná, Bodva a Rimava nad 500, Hornád a Torysa nad 600 a.s.l., vrátane ich prítokov	7
		submontane zone	< 400/500/600 m a.s.l.	prítoky Laborca, Tople, Ondavy do 400 Slanej, Bodvy a Rimavy do 500, Hornádu a Torysy do 600 a.s.l.	8
				Laborec, Topľa a Ondava do 400, Torysa a Hornád do 700 a.s.l.	9
		lowland zone	< 200 m a.s.l.	Hornád, Bodva, Rimava, Slaná a ich prítoky do 200 a.s.l.	10
	Danubian district	montane	> 500/600/700 m a.s.l.	prítoky Váhu Nitry a Ipľa nad 500, Turca a Hronu nad 600 a Oravy nad 700 a.s.l.	11
		submontane zone	< 500/600/700 m a.s.l.	prítoky Váhu Nitry a Ipľa do 500, Turca a Hronu do 600 a Oravy do 700 a.s.l.	12
				Váh od VDŽ po sútok s Oravou (r. km 430), Orava, Turiec od ústia po Antonský potok (64,6), Hron od Zvolena po Hámor (265)	13
				Váh od Klanečnice (r. km 142) po VDŽ (255), Hron od Rudna n/Hr. (113) po Zvolen (174), Ipeľ od Kalinova (159) po Ipeľský potok	14
		lowland zone	< 200 m a.s.l.	Ipeľ a jeho prítoky	15
[illegible] province	Danubian district	submontane	< 300 m a.s.l.	malé toky Panónskej panvy	16
		lowland zone	< 200 m a.s.l.	prítoky Dunaja, Moravy, M. Dunaja, Váhu, Nitry, Žitavy a Hronu	17
				Morava	18
				Malý Dunaj, dolný tok Váhu, Nitry, Žitavy, Hronu a Ipľa	19
				Dunaj r. km 1789,5 – 1880,2	20
				Dunaj r. km 1708,2 – 1789,5	21
	Tisa district	lowland zone	in Pannonicum (< cca 200-300 m a.s.l.)	malé toky povodia Tisy v Panoniku	22
				Bodrog, Latorica, Uh, Tisa, spodný tok Laborca po Strážske (r. km 57,9), Ondavy po Ondavku (r. km 57,6) a Tople po Soľ (r. km 29)	23

Fig. 2. Typology of streams in Slovakia (by K. Hensel) for the purposes of SKM.

Slovak multimetric index (FIS)

Based on former experience from other European countries, and outputs from the FAME Project, the process of selection the metrics for FIS started with the list of metrics used for calculation of EFI (Pont et al., 2004). Each of the ten EFI metrics were assessed using the following criteria required to meet the situation in Slovakia: 1) to reduce ambiguity as much as possible; 2) to consider the complexity of interactions between anthropogenic disturbances and fish communities; 3) maximum simplicity principle („Occam razor“); and 4) applicability of the metrics despite the data deficiency.

Furthermore, the application of some new metrics was considered. The Relative abundance of piscivorous species is a parameter that provides a signal about how a fish community is balanced. The use of this parameter has a long tradition in Slovak (and/or Czechoslovak) ichthyology (e. g. Balon, 1966). Over the last decades, more and more non-native species have appeared in Slovak streams, and several of them have become invasive (Copp et al., 2005; Kováč et al. 2008). The presence of invasive species is a relevant indicator of anthropogenic disturbances (e.g. Moyle and Light, 1996; Marchetti et al., 2004; Ribeiro et al., 2007). Finally, in order to reflect the complexity among the anthropogenic disturbances and the composition of fish communities, Sheldon’s Index of Equitability was also considered. As a result, the final list of metrics used for calculation of FIS was completed as follows:

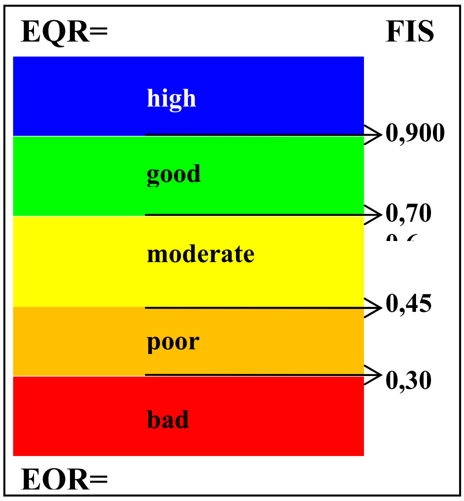
1. Relative abundance of insectivorous species
2. Relative abundance of phytophilous species
3. Relative abundance of lithophilous species
4. Relative abundance of benthic species
5. Relative abundance of rheophilous species
6. Relative abundance of potamodrous species
7. Relative abundance of piscivorous species
8. Relative abundance of invasive species
9. Index of Equitability

The Fish Index of Slovakia is calculated using the software tool FIScalc1.1 that has been developed especially for this purpose. FIScalc works within the Microsoft Excel package. The values of the metrics 1-8 are obtained by calculation of the Ecological Quality Ratio (EQR) that compares the values observed at the monitored site with the reference values for the appropriate stream type using the formula

$$EQR = \frac{mv - la}{ha - la}$$

where mv = metric value, la = lower anchor and ha = high anchor.
Should the value of a metric (calculated as EQR) exceed 1.0 (i.e. if the observed relative density of a metric is higher than the expected value in the reference community), then such a metric enters the calculation of FIS with 1.0. This is because if the relative density of a metric that contributes to indication of the ecological status of a fish community exceeds the expected relative density, then such a metric indicates a high status (class 1), which cannot be further improved. Therefore, the values of the metrics 1-8 always fall within the interval 0 – 1, which is also the case of the metric 9 (Index of Equitability). Finally, the FIS is calculated as a mean value of the metrics 1-9.

Class boundaries
Due to lack of sufficient amount of relevant data, for the beginning, expert judgement was applied to set the boundaries among the 5 classes of ecological status based on the assessment of fish communities. At this time, high or good ecological status (class 1 and/or 2) is accepted only if the fish community achieves at least 70 % EQR of the model reference community, i.e. if FIS ≥ 0.7. The boundaries for the other classes of ecological quality were also proposed as an expert judgement as follows:



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Checking of compliance of national assessment methods with the WFD requirements

Within the Danubian GIG, three MS have developed their national methods – Austria, Czech Republic and Slovakia. Romania has been using the EFI+ approach, Bulgaria and Hungary appear to be in the process of developing their national methods. The Austrian method is reported within the Alpine GIG, therefore the following text focuses on the Czech and the Slovak methods.
The Czech method (CZM) is based on the Czech multimetric index (CZI, see above), which has been developed to assess YOY fish communities. Compatibility of this approach with the common approach has been tested and validated. CZI consists of four metrics - presence of typical species, overall abundance, relative abundance of rheophilous species and relative abundance of eurytopic species. CZI is calculated as the EQR between the expected reference values and the values observed in the field. CZI values range within the interval from 0 to 1 and the index has been found to respond significantly to human pressures ($F_{1, 268} = 21 \cdot 05$; $P < 0 \cdot 0001$; Fig. 3) and to display stability over several years (see the national method description [Horký et al. 2009] for details). This suggests that CZI is compliant with the WFD requirements.

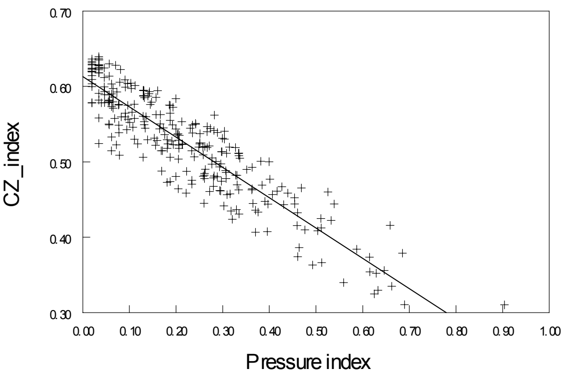

Fig. 3. *Relationship between Czech multimetric index and pressure index (predicted values; data from the Danubian database). The curve was fitted by: y = - 0.4019x + 0.6131; (r^2=0.83).*

The Slovak method (SKM) works with the Fish Index of Slovakia (FIS, see above), a multimetric index that is calculated as the EQR between the expected reference values and the values observed in the field. The principles of the sampling protocol used for SKM are identical with those used for EFI+. FIS was developed at the end of 2008, when not enough field data were available in Slovakia, therefore, the tests and validation of this index have not been completed yet. FIS values range within the interval from 0 to 1. Preliminary tests suggest that some minor modifications may be necessary to improve the response of FIS to human pressures ($F_{1, 268} = 16 \cdot 48$; $P < 0 \cdot 0001$; Fig. 4). Within the next future, when new data from several hundreds monitored sites are expected, FIS will be further tested, in order to ensure its full compliance with the WFD requirements.

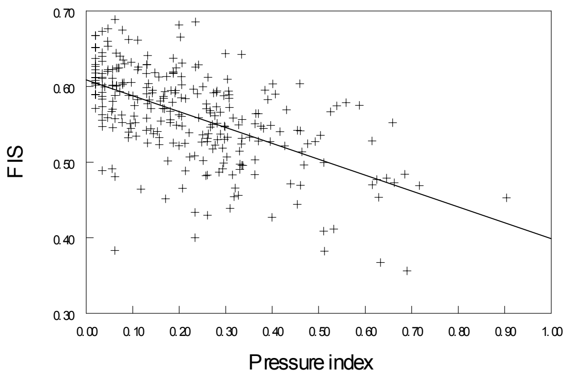

Fig. 4. *Relationship between Fish index of Slovakia and pressure index (predicted values; data from the Danubian database). The curve was fitted by: y = - 0.2101x + 0.6089; (r^2=0.32).*

Progress on Feasibility checking: method acceptance criteria

As mentioned in 2.2., within the Danubian GIG, three MS have developed their national methods – Austria, Czech Republic and Slovakia. Apart from that, Romania, which uses EFI+, is also eligible for the IC process within this GIG. On the other hand, the Fish Index Austria (FIA) cannot be used for IC within the Danubian GIG, since no Ref-Cond sites for FIA in Czech Republic, Slovakia and Romania are available. Therefore, it is not possible to compute EQR for the sites situated in the other member states, and to execute intercalibration according to option 3. Nevertheless, Austrian data are being used for computation of all the three other indices, i.e. CZI, FIS and EFI+ (the latter in Romania).
Although there are essential differences between the Czech and the Slovak methods concerning the overall approach and the sampling procedure (CZM is based on YOY, exclusively), based on the tests and subsequent validation (Horký et al., 2009) it appears that CZM is fully compatible with SKM, and both methods comply with the WFD requirements. Furthermore, both of these national methods address the same pressures, and follow a similar assessment concept. Concerning the intercalibration water body types, both CZM and SKM use a stream typology designed especially for the purposes of national assessment based on fish assemblages, however, these are fully convertible with the intercalibration water body types.
In conclusion, the intercalibration exercise within the Danubian GIG appears to be feasible.

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Progress on Reference conditions/benchmarking

To assure comparability among MS, reference sites for IC within the Danubian GIG were selected as reference sites that are also undisturbed according to the common approach. In other words, within the Danubian GIG, all the reference sites correspond to Ref-Cond sites. Primary analyses showed that there is a significant relationship within all national methods (CZI vs FIS: $F_{1, 268} = 29{\cdot}39$, $P < 0{\cdot}0001$, Fig. 5a; CZI vs EFI+ : $F_{1, 268} = 30{\cdot}53$, $P < 0{\cdot}0001$, Fig 5b; FIS vs EFI+ $F_{1, 268}$ = 66· 30; P < 0· 0001, Fig 5c). No differences in relative misclassification within methods ($F_{2, 540}$ = 1· 81, P < 0· 1649) suggest that there is no pair of methods, whose mutual misclassification is different from others. Average relative misclassification within all methods is 0.93, suggesting that methods approximately vary within two adjacent classes. Comparison of Ref-Cond sites classification showed significant differences ($F_{2, 104}$ = 16· 32, P < 0· 0001, Fig 6), suggesting that harmonisation of boundaries is needed. Harmonization of boundaries will be performed according to the option 3 and the results will be presented in the final report.

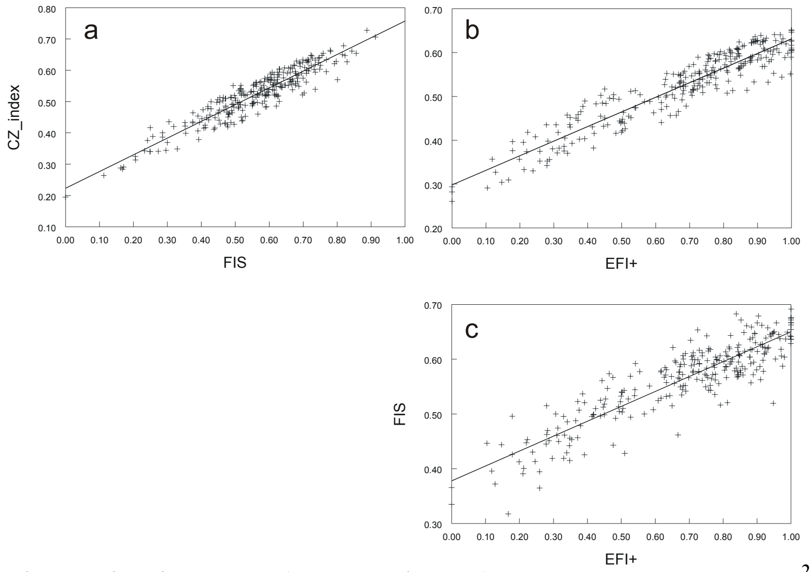


Fig. 5. *Relationship between a) CZI and FIS (y = 0.5344x + 0.2231; r^2=0.87) b) CZI and EFI+ (y = 0.3331x + 0.2981; r^2=0.88) and c) FIS and EFI+ (y = 0.2721x + 0.378; r^2=0.79) (predicted values; data from the Danubian database).*

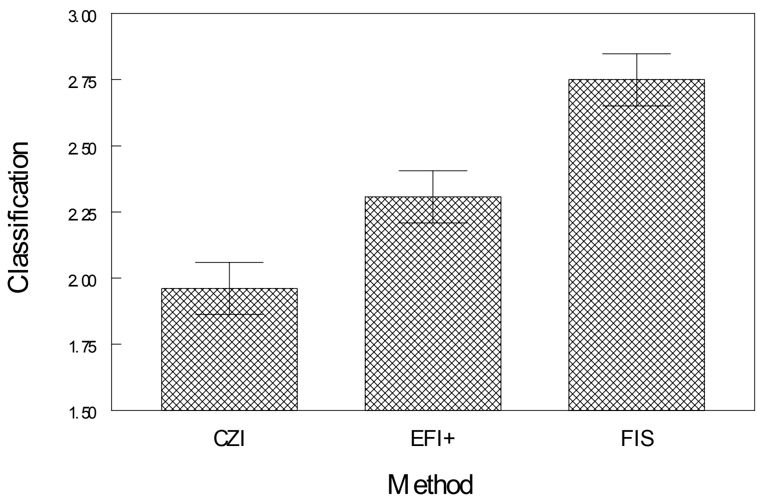


Fig. 6: Ref-Cond sites classification across various methods (1 corresponds to high status, 2 to good status etc.). Values are adjusted means ± S.E.

3. Progress on Collection of IC dataset and Design the work for IC procedure

3.1. Collection of IC dataset

The fish common database is now completed and checked. It contains 4559 sites from 24 countries with only one fishing occasion per site.

Country	Code	Sites	National Reference cond. sites
Austria	AT	259	21
BE (Flanders)	BF	82	0
BE (Wallonia)	BW	146	42
Czech Republic	CZ	93	14
Germany	DE	439	21
Denmark	DK	50	0
Spain	ES	189	102
Estonia	ET	77	7
England & Wales	EW	139	0
Finland	FI	157	95
France	FR	473	90
Greece	GR	161	26
Hungary	HU	133	0
Ireland	IR	495	31
Lithuania	LT	130	44
Latvia	LV	54	17
Luxemburg	LX	20	5
Northern Ireland	NI	75	0
Netherlands	NL	154	0
Norway	NO	70	20
Portugal	PT	150	32
Romania	RO	143	17
Scotland	SC	138	23
Sweden	SE	702	93
Slovakia	SK	76	34
Slovenia	SL	87	10

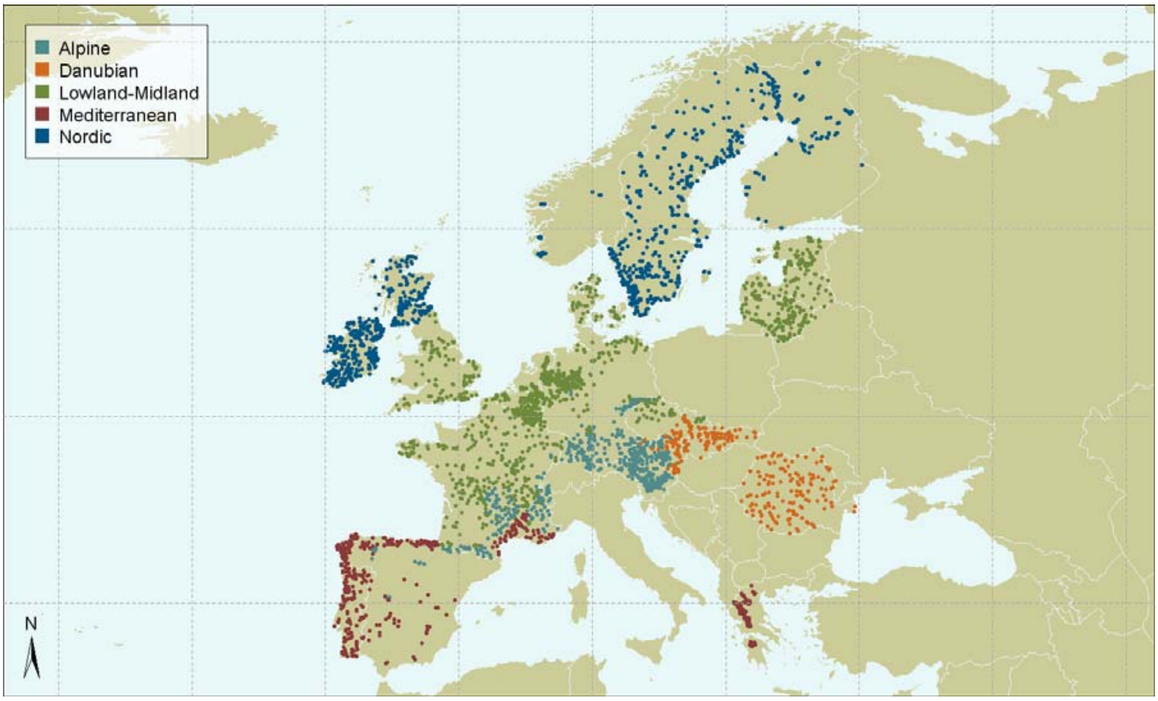
There is no data from only 3 large European countries (Bulgaria, Italy and Poland) and only very partial data from Hungary, which are included in the common database at the moment.

For each site, a large number of parameters are available: composition and abundance of the fish fauna, individual fish lengths, environmental variables, different human pressures (to water quality, hydro-morphological alterations, connectivity alteration) and biological disturbances. The historical and actual presence/absence of diadromous species within each river reach is also recorded when available. In addition, each site has been classified by experts as a reference site (n=744) or a disturbed site at the national level. This classification will be used to define reference sites at the European level in combination with the examination of human pressure intensity (see after).

14 national assessment methods are considered. For each regional group, each method is applied (if it is possible) to all sites of different countries within the considered group.

Site distribution per Regional group

The sites are spatially distributed in 5 groups: Alpine, Danubian, Lowland-Midland, Mediterranean and Nordic.



Number of site per country within each regional group

	Alpine	Danubian	Lowland-Midland	Mediterranean	Nordic
AT	213	46	0	0	0
BF	0	0	82	0	0
BW	0	0	146	0	0
CZ	0	45	48	0	0
DE	187	0	252	0	0
DK	0	0	50	0	0
ES	33	0	0	156	0
ET	0	0	77	0	0
EW	0	0	139	0	0
FI	0	0	0	0	157
FR	141	0	269	63	0
GR	0	0	0	161	0
IR	0	0	0	0	495
LT	0	0	130	0	0
LV	0	0	54	0	0
LX	0	0	20	0	0
NI	0	0	0	0	75
NL	0	0	154	0	0
NO	0	0	0	0	70
PT	0	0	0	150	0
RO	0	143	0	0	0
SC	0	0	0	0	138
SE	0	0	0	0	702
SK	0	76	0	0	0
SL	87	0	0	0	0

Database structure

The common database is organized in 5 tables:

Table	Description
Fishing_occasion	Table of fishing occasions (description of sites, environmental & pressures variables)
Catch	Table of catches (number of fish per specie per site and number of fish less than 150 mm)
Diadromous	Table of diadromous species (number of fish per specie per site)
National_method	Table of the national method (index and class)
Common_metrics	Table of common metrics

Table Fishing_occasion

Site description & environmental variables:

VARIABLE	EXPLANATION
Site_code	Site code
Date	Date
E_latitude	Latitude
E_longitude	Longitude
E_rivername	River name
E_sitename	Site name
E_site_status	National reference condition
E_catchsize	Size of catchment upstream of the sampling site (km²)
E_distsource	Distance from source in kilometers to the sampling site measured along the river. In the case of multiple sources, measurement shall be made to the most distant upstream source (data source: maps, preferrably preferably 1:25 000).
E_altitude	Altitude of the site in meters above sea level
E_slope	Given as slope of streambed along stream (m/km; ‰). The slope is the drop of altitude divided by stream segment length. The stream segment should be as close as possible to 1 km for small streams, 5 km for intermediate streams and at least 10 km for large streams (Data source: maps with scale of preferably 1:25 000).
E_temp_jan	Mean january air temperature at the site (measured for at least 10 years). Given in degrees Celcius (° C).
E_temp_jul	Mean july air temperature at the site (measured for at least 10 years). Given in degrees Celcius (° C).
E_natural_sediment	3 categories: fine (*organic-silt-sand), medium (gravel-pebble-cobble), large (boulder-rock).* Situation before major changes of sediment conditions, always for the dominating substrate! For large rivers,consider dominant sediment in the potamic zone with weak to medium water depths.
E_geomorphological_type	4 categories: naturally *constraint* without mobility (riverbed is fixed), *braided, sinous,and meandering.* Situation before any major human control of river bed!
E_floodplain	Presence of a former floodplain: *yes, no* (e.g. significant area of adjacent landscape flooded at least every 10 years), (data source: old maps, reports, expert judgement). Situation before any major human control of river
E_water_source_type	Glacial-nival dominant or pluvial dominant, based on the hydrograph of the river close to the sampling site.
E_wettedwidth	Wetted width (m). River width at the sampling period
E_geotypo	Geology. Siliceous, calcareous or organic in the catchment upstream (based on dominating category) (data source: geological maps).
E_strategy	Sampling strategy. Definition of how the section was sampled. Whole river width (whole) or only parts of the river (partial).
E_method	Define if electric fishing was carried out by wading, boat or mixed (sites sampled with both - wading and boat).
E_fishedarea	Area of the section that has been definitely sampled given in m².

Table Pressures description

VARIABLE	EXPLANATION
P_barrier	Presence of downstream artifical barriers on the catchment scale
P_barrierup	Artificial barriers upstream from the site
P_barrierdown	Artificial barriers downstream from the site
P_impoundment	Impoundment

P_hydropeaking	Hydropeaking
P_waterabsrt	Water abstraction
P_reservoir	Colinear connected reservoir (fish farms, fish ponds,...)
P_dam	Upstream dams influence
P_watertemp	Water temperature modification (excuding dam effect)
P_chan	Channelisation / Cross section alteration (segment scale)
P_vegrip	Riparian vegetation
P_habalt	Local Habitat alteration (site scale)
P_dyke	Dykes (flood protection)
P_tox	Toxic Risk. Priority substances list
P_waterac	Water acidification
P_waterqualindex	National water quality index (segment scale)
P_wateralt	Water quality alteration (local scale)
P_navigation	Navigation
P_recreational	Recreational use with high intensity (angling, boating,...)
P_specimp	Impairment of indigenous species
P_predation	Heavy predation
P_stockact	Major effect on indigenous populations by stocking activities

Table Catch

VARIABLE	EXPLANATION
Site_code	Site code
Date	Date
Species	Scientific name of species
Run1_number_all	All caught individuals (incl 0+) of the species in run 1
Length_available	Are the lengths available? yes or no
Run1_nb_length150	Number of fish ≤ 150 mm in run 1

Table Diadromous Species

VARIABLE	EXPLANATION
Site_code	Site code
Date	Date
Diadromous_species	Scientific name of selected diadromous species
Historical_occurrence	Historical occurrence in the river segment (end 19th century, beginning XXth century)
Actual_occurrence	Actual.occurrence in the river segment

Table National_methods

Country	Code	Method name	Country	Code	Method name.
Austria	**AT**	FIA	Lithuania	**LT**	LFI
BE (Flanders)	**BF**	IBI	Latvia	**LV**	No method
BE (Wallonia)	**BW**	IBIP	Luxemburg	**LX**	No method
Czech Republic	**CZ**	CZI	Northern Ireland	**NI**	Under development
Germany	**DE**	FIBs	Netherlands	**NL**	NLI
Denmark	**DK**	No method	Norway	**NO**	No method
Spain	**ES**	Under development	Portugal	**PT**	No method
Estonia	**ET**	ETI	Romania	**RO**	EFI+
England & Wales	**EW**	FCS2	Scotland	**SC**	Under development
Finland	**FI**	FIFI	Sweden	**SE**	VIX
France	**FR**	FBI	Slovakia	**SK**	FIS
Greece	**GR**	No method	Slovenia	**SL**	No method
Ireland	**IR**	No method			

Table Common_metrics

Variable	Description
Site_code	Site code
richesse	Number of species
captures	Number of fish
psalmo	% of intolerant species individuals
dens_WQO2_O2INTOL_tot	Density of oxygen depletion intolerant species
dens_HTOL_HINTOL_tot	Density of individuals that belong to species intolerant to habitat degradation
ric_HabSp_RHPAR_tot	Richness in number of species of rheophilic reproduction habitat species
dens_Repro_LITH_tot	Density of species with lithophilic reproduction habitat
dens_HTOL_HINTOL_150	Density of ind. with length ≤ 150 mm that belong to species intolerant to habitat degradation

Non available data per variable

For all the following tables, the number of data which are missing per each environmental variable are indicated (orange cells when at least one).

Environnemental variables

Variable	AT	BF	BW	CZ	DE	DK	ES	ET	EW	FI	FR	GR	IR	LT	LV	LX	NI	NL	NO	PT	RO	SC	SE	SK	SL
Nb of sites	259	82	146	93	439	50	189	77	139	157	473	161	495	130	54	20	75	154	70	150	143	138	702	76	87
E_latitude	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E_longitude	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E_catchsize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E_distsource	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E_altitude	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E_slope	0	0	0	0	0	0	0	0	0	0	0	19	0	0	2	0	0	0	0	0	0	0	0	0	0
E_temp_jan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E_temp_jul	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E_natural_sediment	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E_geomorphological_type	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E_floodplain	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E_water_source_type	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E_wettedwidth	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E_method	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E_fishedarea	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Pressure variables

Variable	AT	BF	BW	CZ	DE	DK	ES	ET	EW	FI	FR	GR	IR	LT	LV	LX	NI	NL	NO	PT	RO	SC	SE	SK	SL
Nb of sites	259	82	146	93	439	50	189	77	139	157	473	161	495	130	54	20	75	154	70	150	143	138	702	76	87
P_barrier	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P_barrierup	0	0	0	0	8	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P_barrierdown	0	0	0	0	8	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P_impoundment	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P_hydropeaking	0	0	0	0	8	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P_waterabsrt	0	0	0	0	195	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P_reservoir	0	0	0	0	8	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P_dam	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P_watertemp	0	0	0	0	8	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P_chan	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P_vegrip	0	0	0	0	147	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P_habalt	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P_dyke	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P_tox	0	33	2	0	121	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P_waterac	0	3	0	0	8	0	0	0	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P_waterqualindex	0	2	2	0	11	0	0	13	0	0	13	0	0	0	54	0	0	0	0	0	0	0	0	0	0
P_wateralt	0	41	2	0	173	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P_navigation	0	0	0	0	8	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P_recreational	0	0	0	0	8	0	189	0	0	157	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
P_specimp	22	0	0	0	8	0	180	0	134	0	148	0	0	0	0	0	0	0	0	0	0	0	0	76	0
P_predation	51	0	0	0	8	0	180	0	134	157	174	0	0	0	0	0	0	0	0	0	0	0	0	76	0
P_stockact	26	0	0	0	8	0	180	0	134	157	0	0	0	0	0	0	0	0	0	0	0	0	0	76	0

Nota: the 3 last pressures are not considered to define the site status (minimally disturbed sites).

3.2: Progress on Reference conditions/benchmarking

3.2.1 Definition of Reference sites

Reference conditions have to be comparable between member states. But it is also necessary to take into account the specificity of rivers at the regional level and also the criteria already used at the national level to select reference sites.

For this reason, the river fish IC group agreed to consider two criteria for selecting reference sites:

1) At the European level, all reference sites have to be qualified as minimally disturbed sites at the local scale, using a set of common variables describing the intensity of different types of pressures (water quality, hydro-morphological pressures, connectivity alteration). These sites are mentioned as "undisturbed sites".
2) At the national level, each member state has selected a list "national reference sites" considering its own reference condition criterias.
3) Finally, a site will be selected as a reference site at the European level when the site is both an undisturbed site and a national reference site.

In that way, we could assume that the reference sites selected within all Europe reflect comparable reference condition (in relation with the considered pressures) and also the regional specificity of rivers at the regional/national scale.

Undisturbed sites selection:

Using the criteria list (see below) defined previously during the Sharfling meeting (November, 2008), a list of undisturbed sites have been defined.

Pressure type	Scale	Pressure intensity				Nb of modalities
Presence of downstream artifical barriers on the catchment scale	catchment	no	low	high		3
Artificial barriers upstream from the site	segment	no	low	medium	high	4
Artificial barriers downstream from the site	segment	no	low	medium	high	4
Impoundment	site	no	low	high		3
Hydropeaking	site	no	low	high		3
Water abstraction	site	no	low	medium	high	4
Colinear connected reservoir (fish farms, fish ponds ...)	segment	no	high			2
Upstream dams influence	site	no	low	high		3
Water temperature modification (excuding dam effect)	site	no	high			2
Channelisation / Cross section alteration (segment scale)	segment	no	low	medium	high	4
Riparian vegetation	site	no	low	medium	high	4
Local Habitat alteration	site	no	low	medium	high	4
Dykes (flood protection)	segment	no	low	medium	high	4
Toxic Risk. Priority substances list	segment	no	low	high		3
Water acidification	segment	no	low	high		3
National water quality index (segment scale)	segment	no	low	medium	high	4
Water quality alteration (local scale)	site	no	low	medium	high	4
Navigation	segment	no	high			2
Recreational use with high intensity (angling, boating,..)	site	no	high			2
impairment of indigenous species	segment	no	high			2
heavy predation	site	no	high			2
major effect on indigenous populations by stocking activities	segment	no	high			2

Criteria used for undisturbed sites selection. Only sites characterized by no or low pressure intensity (depending of the considered pressure) are selected (red modalities).

In addition[1], we only considered sites with at least 30 fish caught and with a fished area equal or larger than 100 m^2.

Using these criteria, the total number of sites selected is 911 sites.

Country	AT	BF	BW	CZ	DE	DK	ES	ET	EW	FI	FR	GR	IR
Nb sites	27	0	47	8	15	0	79	19	7	68	85	32	161
Country	LT	LV	LX	NI	NL	NO	PT	RO	SC	SE	SK	SL	
Nb Sites	64	23	5	0	0	4	28	35	26	105	39	28	

Number of undisturbed sites per country

National Reference sites

The total number of sites selected as reference sites at the national level is 599 (when only considering sites with at least 30 fish caught and with a fished area equal or larger than 100 m^2).

Country	AT	BF	BW	CZ	DE	DK	ES	ET	EW	FI	FR	GR	IR
Nb sites	21	0	41	14	20	0	75	7	0	60	86	18	28
Country	LT	LV	LX	NI	NL	NO	PT	RO	SC	SE	SK	SL	
Nb Sites	44	16	5	0	0	4	32	16	16	52	34	10	

Number of national reference sites

Reference sites selection at the European level

Sites selected as a reference site at the European level are both undisturbed site and national reference site. The total number is 547.

		National reference sites	
		NO	YES
Undisturbed Sites	NO	2589	52
	YES	364	**547**

The comparison of the two types of sites (undisturbed and national reference) shows that 91.3% of national reference sites are also “undisturbed sites”. But only 40.0% of undisturbed sites are classified as national reference sites.

Country	AT	BF	BW	CZ	DE	DK	ES	ET	EW	FI	FR	GR	IR
Nb sites	15	0	40	14	13	0	74	7	0	59	67	18	25
Country	LT	LV	LX	NI	NL	NO	PT	RO	SC	SE	SK	SL	
Nb Sites	43	16	2	0	0	4	23	16	15	52	34	10	

Number of European reference sites per country

[1] At least for the comparison of reference conditions between countries using common metrics.

3.2.2 Comparison between Reference sites using common metrics

The selection of reference sites are mainly based on pressure criteria and in addition on criteria defined at the national scale. These last criteria can include some element related to the quality of the fish community within reference sites. Nevertheless, if the lack of significant pressure is a necessary minimal criterion for a reference sites, it remains also necessary to test in addition that the fish community are also not or minimally impacted. Using common functional metrics calibrated at the European scale is a way to ensure that the status of fish communities is similar between members states when only considering reference sites (cf § 3.2.1).

The common metrics used for the fish intercalibration exercise are derived from the fish index developed during the EFI+ project[2] (http://efi-plus.boku.ac.at/software). Several modifications have been introduced in order to improve the efficiency of the method (see Annex 1).

- The definition of the two river zones (Salmonid type zone and Cyprinid type zone) is now based on the direct prediction of the percentage of intolerant species, using a specific model. A specific index is computed for each river zone.
- The ecoregions are no more considered in the calibration of the predicted values of the metrics.
- Within the cyprinid zone, the sites characterized by a low relative abundance of species requiring a **rheophilic reproduction habitat** are not correctly assessed. Several tests show that a minimum proportion of 37% of these individuals is required to correctly assess the site with the common metrics.

The common metrics are summed up to get a common index for each site. Two common indices are available, depending of the river zone: The salmonid-type index and the cyprinid-type index.

A detailed presentation of the method of the common metrics and of the two common indices are available in the Annex 1.

Transformation of the common indices in EQR

The common metrics are first transformed in EQR. The index is transformed in EQR by dividing the index value by the median value of the sites classified as undisturbed (see before).

Only reference sites with a high relative abundance of rheophilic reproductive species (> 37%) are considered (common are not considered as always valid for sites with a low proportion of rheophilic species, see Annex 1 for details). Then, the total number of reference sites considered is 523.

The distribution characteristics of the two common indices for reference sites are given below:

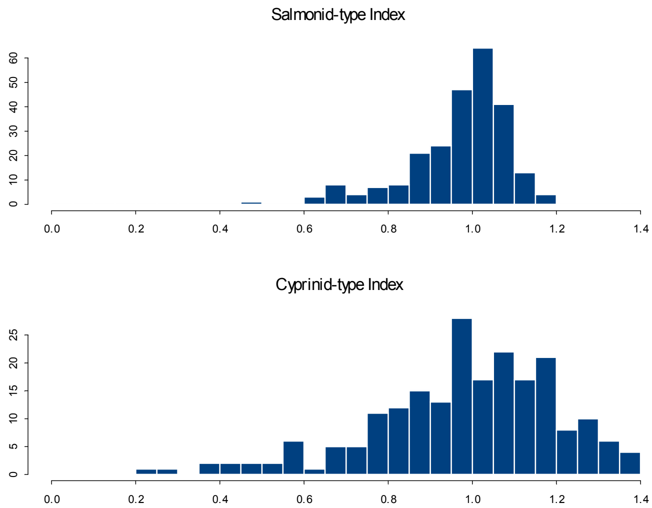
[2] EFI+ - Improvement and Spatial extension of the European Fish Index. A project under the 6th Framework Programme, task “Ecological Status Assessment”. Priority “Integrating and Strengthening the European Research Area - Scientific Support to Policies”, Task 4. Contract Number 044096

	Min	1st Quart.	Median	Mean	3rd Quartile	Max
Salmonid river zone	0.414	0.774	0.838	0.815	0.876	1.000
Cyprinid river zone	0.151	0.628	0.730	0.716	0.829	1.000

A specific median value is then used for each of the two river zones.

The two indices, when expressed in EQR have the following characteristics for reference sites.

Common index EQR	Min	1st Quart.	Median	Mean	3rd Quartile	Max
Salmonid river zone	0.494	0.924	1.000	0.973	1.046	1.193
Cyprinid river zone	0.207	0.861	1.000	0.982	1.136	1.370



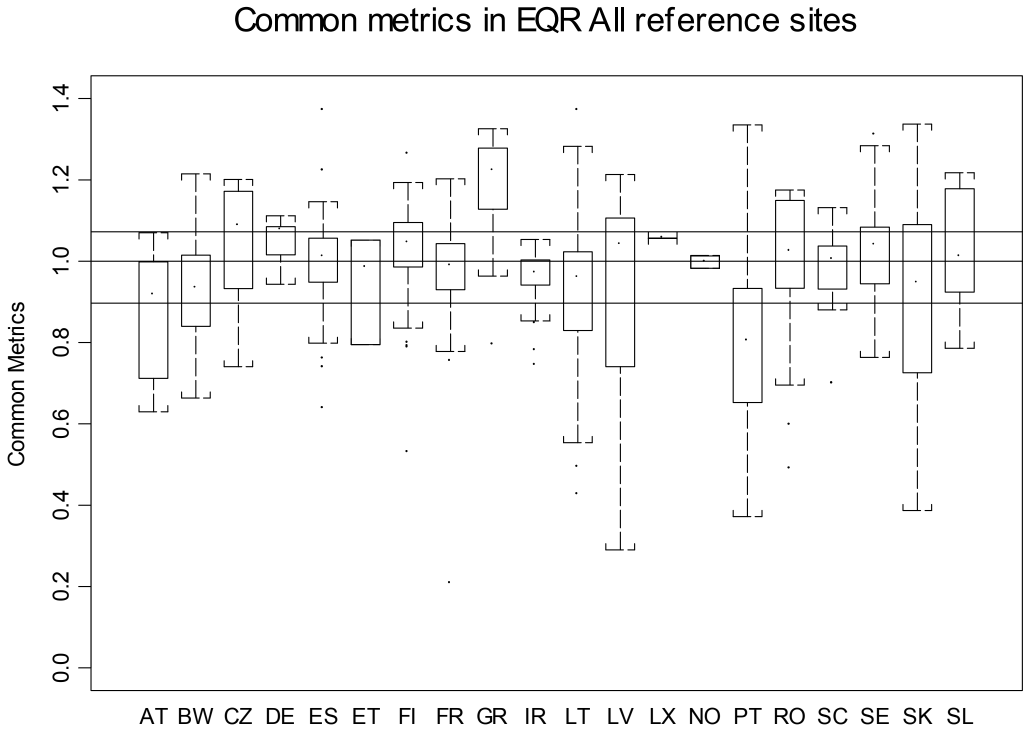
Distribution of the two indices values for reference sites after transformation in EQR

The distributions of the two indices have quite similar mean values (in addition to the median values). The variability of the cyprinid-type index is higher than the variability of the salmonid-type index. The corresponding values for the first quartile are not similar. Then, for the same EQR value, the deviation from the reference condition is higher for the Salmonid type than the cyprinid type index. Nevertheless, the 1st quartile values remains relatively comparable.

This remark could be considered as general for all comparisons between different methods. Depending of the variability of the distribution of reference sites values, the same EQR value could not correspond to the same deviation from the reference condition for two different methods expressed in EQR.

Reference sites EQR values per countries

As a first result, the distributions of reference sites EQR values are given per country (see below). In general, the values are comparable between countries, with the exception of Portugal, and some sites from mainly AT, LV and SK. This could be due for a part to a misclassification of sites between the two river zone and a more detailed analysis is needed.



Common indices expressed in EQR values for all reference sites per country. Upper line, Middle line and lower lines: 3rd quantile, median and 1st quantile values of the distribution of reference sites for all Europe.

Nevertheless, and as a first conclusion, reference condition seems to be comparable between countries.

3.2.3 Definition of an overall pressure index and common metrics responses

A pressure index is defined using all the pressure retained for the definition of undisturbed sites, i.e. 17 individual pressures.

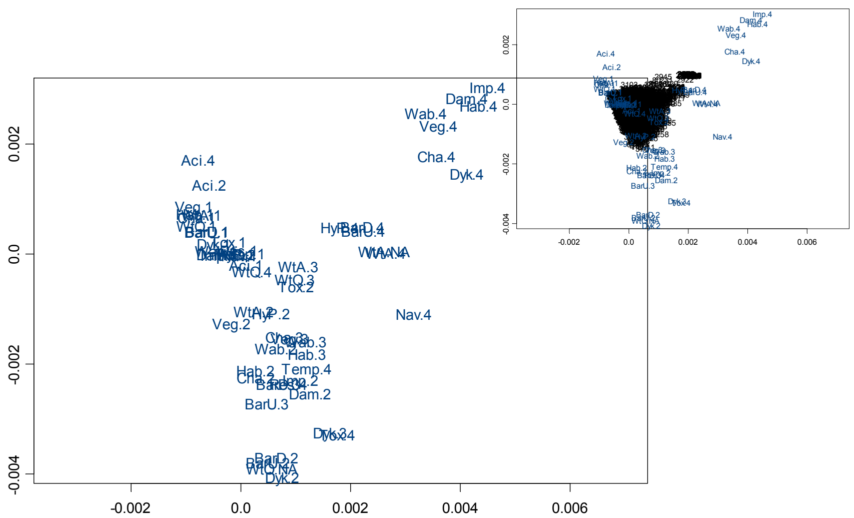
Due to missing pressures data, some sites are excluded, mainly all sites from Flanders and 72% of German sites. For Latvia, only the pressure related to Water Quality Index was missing. These values have been replaced by the values of the pressure related to Water alteration (the general correlation between these two variables is quite good).

The data are analysed using a multivariate procedure. As all the variables are ordinate qualitative variables but without clear assumptions about the relative strength of each variable compared to others, an appropriate method is the MCA (Multiple Correspondence Analysis) which allows considering variables expressed by modalities. The results are shown on figure XXX. The first axis is rescaled from 0 to 1 and is divided in five classes of equal range (class 1: 0-0.2, class 2: 0.2 – 0.4, classe 3: 0.4-0.6, classe 4, 0.6-0.8, class 5: 0.8-1.0).

All undisturbed sites are classified in pressure class 1. They represent 42.7% of the sites belonging to this pressure class. Pressure class 1 sites highly affected by high level pressures represent only 19% of all sites, and most of them (88%) are strongly affected by only one pressure.

The pressure Water acidification is an exception. This pressure is completely independant from the others. Most of sites qualified as highly or moderately affected by acidification are classified in Pressure class 1 (respectively 84.2% and 87.2%).

At the opposite, all sites from Pressure class 4 and 5 are characterized by high level of pressures and most of them are affected by several pressures: respectively 6.2 and 9.2 high level pressures per site. **Then the first axis of the MCA could be considered as a good synthesis of the general level of pressures acting on the site.**



Multiple Correspondence Analyse of Pressures. Coordinates of modalities of the 17 variables on the first and the second axis. Upper Right: sites coordinates.

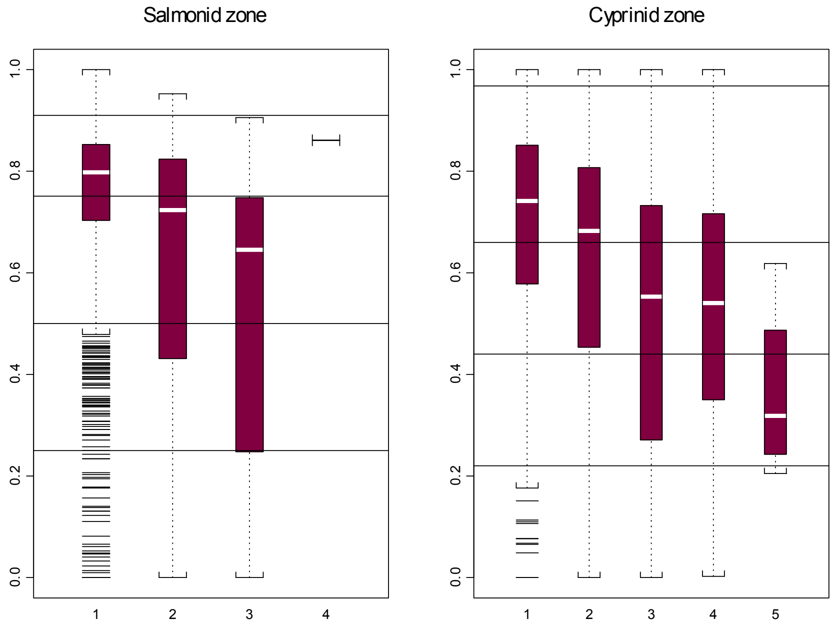
Each modalities is denominated by the name of the pressure and a figure corresponding to the pressure level (1: no, 2: low, 3: medium, 4: high)

List of Pressures: BarU.(Artificial barriers upstream from the site), BarD.(Artificial barriers downstream from the site), Imp.(Impoundment), Hyp.(Hydropeaking), Wab.(Water abstraction), Res.(Colinear connected reservoir (fish farms, fish ponds ...)), Dam.(Upstream dams influence), Temp.(Water temperature modification (excuding dam effect)), Cha.(Channelisation / Cross section alteration (segment scale)), Veg.(Riparian vegetation), Hab.(Local Habitat alteration), Dyk.(Dykes (flood protection)), Tox.(Toxic Risk. Priority substances list), Aci.(Water acidification), WtQ.(National water quality index (segment scale)), WtA.(Water quality alteration (local scale)), Nav.(Navigation)

The second axis allows distinguishing between two types of association of high pressures. Positive values are associated with sites highly degraded sites considering their hydromorphological status: maximal alteration for channelisation, instream habitat, dykes, impoundment, water abstraction and riparian vegetation. These sites are also associated, to a lesser extinct, to high level of water quality alteration, hydropeaking and presence of barriers. Negative values on the second axis are more associated with a mixture of sites combining particular physical and chemical pressures: water temperature alteration, high toxic risk, presence of collinear reservoirs,…

Common indices responses to pressures (preliminary results)

The common indices (common metrics) respond significantly to an increase of pressure.



Responses of the common indices to the overall pressure index (5 classes).

ANNEX 1:

METHODOLOGY USED FOR THE COMPUTATION OF THE COMMON METRICS

The common metrics used for the fish intercalibration exercice are derived from the fish index developed during the EFI+ project[3] (http://efi-plus.boku.ac.at/software). Several modifications have been introduced in order to improve the efficiency of the method.

- The definition of the two river zones is now based on the direct prediction of the percentage of intolerant species, using a specific model. A specific index is computed for each river zone.
- The ecoregions are no more considered in the calibration of the predicted values of the metrics.
- Within the cyprinid zone, the sites characterized by a low relative abundance of species requiring a **rheophilic reproduction habitat** are not correctly assessed. Several tests show that a minimum proportion of 37% of these individuals is required to correctly assess the site with the common metrics.

The new European Fish Index (EFI+) is a multimetric index based on a predictive model that derives reference conditions from abiotic environmental characteristics of individual sites and quantifies the deviation between the predicted fish assemblage (in the "quasi absence" of any human disturbance) and the observed fish assemblage (described during a fish sampling occasion). The metrics used are based on functional guilds describing the main ecological and biological characteristics of the fish assemblage[4].

The new version of this method is summarized below.

1.1 Functional River Typology

Two river zones are distinguished based on the relative abundance of individuals from species characterized as intolerant species: oxygen depletion intolerant, habitat alteration intolerant, stenothermic, lithophilic or speleophilic reproduction type species and with a rheophilic reproductive habitat. These 17 species are:

Cobitis calderoni	*Coregonus lavaretus*	*Cottus gobio*
Cottus poecilopus	*Eudontomyzon mariae*	*Hucho hucho*
Lampetra planeri	*Salmo salar*	*Salmo trutta fario*
Salmo trutta lacustris	*Salmo trutta macrostigma*	*Salmo trutta trutta*

[3] EFI+ - Improvement and Spatial extension of the European Fish Index. A project under the 6th Framework Programme, task "Ecological Status Assessment". Priority "Integrating and Strengthening the European Research Area - Scientific Support to Policies", Task 4. Contract Number 044096

[4] EFI+ was an EC-funded research project aimed to contribute to the implementation of the Water Framework Directive. Research institutions based in 15 countries participated in the EFI+ project. The original project consortium consisted of partners based in **Austria, Finland, France, Germany, Hungary, Italy, Poland, Portugal, Romania, Spain, Sweden, Switzerland and UK.** In addition, partners from the **Netherlands** (RIZA/Deltares) and **Lithuania** (University of Vilnius) participated in the EFI+-project as self-funded associate partners.

Salmo trutta marmoratus	*Salvelinus fontinalis*	*Salvelinus namaycush*
Salvelinus umbla	*Thymallus thymallus*	

A site is classified as a salmonid river zone site or a cyprinid-type site when the relative abundance of these intolerant species is respectively over or below 76.1%. A specific model (logistic regression) has been developed to predict the river type for any river site.

1.2 Metrics selection

The metrics used to calculate the Salmonid and the Cyprinid Fish Index are defined as follow:

Zone / Index	Metric name	Detailed name - guild
Salmonid	Ni.O2.Intol	Density (number of individuals per 100m² in the 1. run of a sample site) of species **intolerant to oxygen depletion**, always more than 6 mg/l O_2 in water.
	Ni.Hab.Intol.150	Density (number of individuals per 100m² in the 1. run of a sample site) ≤ 150 mm (total length) of species **intolerant to habitat degradation**.
Cyprinid	Ric.RH.Par	Richness (number of species in the 1. run of a sample site) of species requiring a **rheophilic reproduction habitat**, i.e. preference to spawn in running waters.
	Ni.LITHO	Density (number of individuals per 100m² in the 1. run of a sample site) of species requiring **lithophilic** reproduction habitat, species which spawn exclusively on gravel, rocks, stones, cobble or pebbles. Their hatchlings are photophobic.

These metrics have been selected among several hundreds of candidate metrics based on species guilds related to different biological and ecological traits and expressed in different units (richness, density, and biomass). Size classes have also been considered for most of these candidate metrics (number of individuals ≤ or > 150 mm).

The Salmonid/Cyprinid fish assemblage typology is used during the process of metric standardisation and selection. For each river zone (Salmonid versus Cyprinid), the metrics are selected in a way that they can be considered as representative of the fish assemblage, i.e. each metric is represented by a significant part of the total number of individuals in the absence of any human disturbance.

Metrics based on oxygen intolerant or habitat intolerant guilds cannot be used for a large part of sites belonging to the Cyprinid river zone because the relative abundance of these "intolerant" individuals is already low even in the absence of any human disturbance. Then, at the opposite of the Salmonid river zone, an increase of pressure would be difficult to detect with these two metrics, especially considering the uncertainties associated with the sampling.

Metrics based on rheophilic and lithophilic reproduction habitat are more adapted to the Cyprinid zone. But there they are very often too permissive for the Salmonid zone. For most of pressures (but with the exception of impoundments), the abundance of rheophilic species is not affected enough to allow a significant response of the metric most of time.

A similar limitation is observed in the Cyprinid zone for slow flowing rivers, whatever the river size. In such case, rheophilic species are naturally rare and the two metrics are not enough sensitive to pressures. Several test showed that this lack of sensitivity appears when the relative richness of rheophilic reproductive habitat species is lower than 37 %. Then the results of the proposed index have to be considered with caution in such type of rivers.

1.3 Metrics computation

For each metric and for a given site a statistical model is used to predict the metric value in the absence or quasi-absence of human disturbance (i.e. a value corresponding to "a reference condition"). These expected values are computed from the 6 following environmental parameters using generalised linear models:

- Two combinations of variables describing mainly and respectively the size and the geomorphologic type of the river: distance form source (km), drainage area ((km^2), presence of a floodplain, water Source type (glacial/nival versus pluvial), geomorphologic style (braided, meandering, sinuous, constraints)
- Actual.river.slope ($m.km^{-1}$)
- Mean Annual Air Temperature in july (°C)
- Mean Annual Air Range temperature between July and January
- Natural river bottom granulometry (boulder/rock, gravel/pebble/cobble, sand/silt dominated)

In addition, the fished area (m^2) and the sampling method (boating or wading) are required.

These models were calibrated using 533 "undisturbed" sites distributed among all Europe. These sites cover a large climate gradient from south Portugal to Finland but very large rivers (upstream drainage area > 10,000 km^2) are under –represented.

All the four selected metrics are modelled after taking into account a measure of the total richness or the number of fish caught depending of the metric, which allow the predictions to be relatively independent from the number of fish caught (sampling effort).

The metric itself reflect the distance between the predicted value (based on the prediction of the model from the considered environmental variables) and the observed value (estimated from the field sampling). It is obtained by:

- centering and reducing the residuals (Observed value minus predicted value) using the mean and standard deviation of the distribution of the 533 calibration (undisturbed) sites values,
- and rescaling the metric values from 0 to 1.

After rescaling, the median value of each the four metrics, when considering only undisturbed sites is equal to 0.80.

1.4 Index computation

Two indices, each composed of two different metrics, can be computed depending on the river zone classification of a given site:

- Salmonid Dominated Fish Assemblage Index (Salm.Fish.Index) for sites classified as Salmonid Dominated Fish Assemblage River Zone (Salmonid river type)

Salm.Fish.Index = (Ni.Hab.150 + Ni.O2.Intol) / 2

Cyprinid Dominated Fish Assemblage Index (Cypr.Fish.Index) for sites classified as Cyprinid Dominated Fish Assemblage River Zone (Cyprinid river type)

Cypr.Fish.Index = (Ric.RH.Par + Ni.LITHO) / 2

The index varies from 0 to 1.

The new automatic classification (based on prediction of the river zone from abiotic environmental parameters) is more efficient than the previous one used in the EFI+ project. Nevertheless, the risk of misclassification remains and the user, as experts, will have to evaluate the situation and to confirm the proposed classification or choose the most appropriate of the two fish indices. But, in any case, the only criterion which has to be considered is the expected proportion of intolerant species (individuals) and not a comparison with any other national river classification.

1.5 Index limitation

Fish fauna: The indices have been developed on sites located in areas characterized by the fish fauna considered in the EFI+ project and correctly classified in the functional species guilds. In practice, at present, the index is not covering correctly the Balkan areas (excluding the Danube catchment), and probably not the areas located eastern from the present limit of the European community.

Low proportion of rheophic species: As previously indicated, the functional metrics used are not enough sensitive for river sites characterized by a naturally low relative occurrence of rheophilic reproductive habitat species (in general less than 37%). In such situation, the index values are in general too low.

These sites are not characterized by the size of the river (small or large) but mainly by the dominance of very slow flowing conditions associated with the present of fish species typical from more lentic environment than the main channel of most of European rivers (lowland rivers -large or small- with a very low river slope, flood plain water bodies most often isolated, ponds and shallow lakes,…). In addition, a part of Mediterranean sites are also concerned by this restriction.

Then the results of the proposed index have to be considered with caution in such type of rivers. Additional analyses are needed to select metrics appropriate for such particular river type (i.e. lenitic habitat species, phytophylous reproductive species, ….).

As one of the consequence, the fish index, in the present state, cannot be used for surveys undertaken in lateral water bodies of the floodplain and is only calibrated correctly for sites sampled in the main river channel.

Particular environments: Some environmental situations are not correctly handled by the two indices: presence of a natural lake upstream from the site, presence of a winter dry period, “organic” rivers (main substrate of the river is organic). In the last case (“organic” rivers”) , such river reaches are in general dominated by slow flowing water species and rheophilic species are rare.

Although no clear differences in index behaviour have been observed for intermittent/ summer dry rivers, the indices must be used with caution due to the low number of undisturbed sites available to calibrate and test the index in these conditions.

River size: The metrics have been mainly calibrated for rivers with an upstream drainage area less than 10,000 km^2. Independent of the sampling method, the river size seems not to significantly influence the index values for undisturbed sites when the upstream drainage area is less than 10,000 km^2. **Nevertheless, the index should be used with caution in the lowland reaches of very large rivers as no reference sites from these reaches have been available for the calibration of the index**. In those cases the index uses only extrapolated predictions based on the trends observed in the models.

Low species richness: The EFI+ is based on the analysis of the whole fish assemblage and metrics are based on the relative occurrence or abundance of functional guilds of species. Therefore, it is clear that assemblage-based metrics are unsuitable when the richness of a site is limited to one species. In most cases in Europe this relates to small headwater rivers where brown trout are the only fish species present.

In principle, one metric selected for the Salmonid type (the abundance of individuals < 15 cm of habitat intolerant species (Hab.Intol.150)) should be able to give a response when only trout is present. But at present, additional analysis are needed to test the efficiency of this metric alone in such situations.

The only case where species composition based metrics could react (mainly Ni.O2.Intol) is when the response to a disturbance is an increase of species richness (e.g. impoundments in head waters).

Number of fish caught: When few specimens were caught the software still allows the calculation of the indices, but the results must be considered with caution. The same caution applies when the sampled area is smaller than 100 m^2. These criteria reflect the need for sampling to be adequate to assess the abundance and structure of the fish assemblage and the population structure of the species caught.

The index seems relatively independent from the number of fish caught. This is directly related to the modelling methods used. All the four selected metrics are modelled after taking into account a measure of the total richness or the number of fish caught depending of the metric. Nevertheless, too low a number of fish caught would alter the capacity of the index to assess robustly the ecological status. The user has to be careful when the number of fish caught is less than 30 individuals.

Two cases could be problematic and the EFI+ should be used with care:

- undisturbed rivers with naturally low fish density,
- heavily disturbed sites where fishes are nearly extinct.

In the first case, fish are close to the natural limits of occurrence and therefore might not be good indicators for human impacts. The occurrence of fish in those rivers is highly coincidental and therefore not predictable. If the very low density is caused by severe human impacts more simple methods or even expert judgement are sufficient to assess the ecological status of the river. Consequently, when no fish occur at a site, this method is not applicable.

Sampling method: The EFI+ has been calibrated using only fish data obtained from single-pass electric fishing (or first run of a depletion survey). Therefore, the model is only calibrated using catch-per-unit-effort (CPUE) data and not from quantitative population estimates. If data population estimates from multiple passes are used (i.e. same site fished several times and catches cumulated) the EFI+ will produce erroneous results. Therefore, where multi-pass sites are considered, only the first run data should be used to calculate the indices.

The sampling method (boating or wading) has a clear impact on the index values, especially for sites classified in the Cyrpinid River zone. In most cases sites sampled by boating tend to exhibit lower index values. The metrics values have to be used with caution when sites have been sampled by boating in this river zone.