

Italian document on class boundaries setting and normative definitions for the IC Mediterranean GIG, Rivers (M1, M2, M4 and M5) UPDATE – March 2007 version

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Country	Italy
Classification System:	STAR Intercalibration Common Metric Index (STAR_ICMi), type specific
General Description Part 1.	<p><u>General approach and introduction</u></p> <p>The general approach used to derive class boundaries, which is the same for all types and GIGs Italy is involved in (i.e. Alpine, Central and Mediterranean), the features of the index being inter-calibrated, the calculation options and field techniques will be presented in the first part of this document. The results for each type, in terms of boundary values, relationship between quality classes and biological metrics will be described in its second part. This document represents an update of the document provided to the Med GIG Coordinator on the 1st of August and follows the discussions carried out and decisions taken within the Mediterranean GIG, after the October 2006 ECOSTAT meeting.</p> <p>In Italy, bio-monitoring based on aquatic invertebrates has a long history. The method in use before the Water Framework Directive was the Indice Biotico Esteso (IBE: Ghetti, 1997; APAT-IRSA/CNR, 2004) that only partly satisfies the WFD requirements. New, type-adapted assessment modules are under development to fully comply with the WFD and fulfil the needs of the different WFD monitoring types. Most of them will be ready by the end of 2007, to meet the terms of the WFD monitoring plan. Because they are in a refinement stage, i.e. they are being directly related one to each other to guarantee a comparable assessment of ecological quality, the relation to Intercalibration metric(s) (ICMi) is highly beneficial to finally set class boundaries. Thus, Italy has decided to adopt the STAR_ICMi, the ICM index formally in use in the Central and Mediterranean GIGs for the IC process, as the official Italian method for setting quality class boundaries. The boundaries for each of these original assessment modules being provided for WFD monitoring – and possibly adapted to monitoring aims, stressor acting, local tradition and expertise – will be derived starting from those set for the STAR_ICMi.</p> <p>Actually, the STAR_ICMi is used by Italy as: a) ‘an interim common WFD assessment method for the purposes of the intercalibration exercise’ (see the IC Guidance: EC, 2005) and b) the legitimate way to determine class boundaries for any other method more explicitly devoted to standard monitoring for invertebrates.</p> <p>Within the Mediterranean GIG, a pool of different Intercalibration Common Metrics indices was tested. The results obtained with the Mediterranean Quantitative and the STAR ICMi are very similar and usually, at least in Italy, the STAR_ICMi performs</p>

	<p>better in relation to pressures and gives slightly higher R^2 values when regressed with other methods. Thus, to ensure a direct comparability with the CB GIG, and to avoid possible doubts about the validity of the boundaries adopted in the Mediterranean GIG, the STAR_ICMi was selected by the Med GIG as the only index to be used for official comparison within the GIG. Further information on the Intercalibration Common indices developed and preliminarily used within the Mediterranean GIG different from the STAR_ICMi can be find in the documents previously submitted from Italy and other MS for the IC process (July/August 2006).</p> <p><u>Description of the STAR Intercalibration Common Metric Index (STAR_ICMi) (Buffagni et al., 2005; 2006)</u></p> <p>The STAR_ICM index was explicitly designed for European IC purposes and it represents one of the indices used in various GIGs for the comparison and harmonization of class boundaries of different MSs. For the CB_GIG, it is presently the only one in use, and also in the Med_GIG it was selected as the common ICM index to be used for comparison. Its WFD compliancy has been discussed and demonstrated elsewhere (Wasson & Buffagni, 2005). The index was built to assess the overall (i.e. general) degradation of a river site, not being aimed at detecting the impact of single stressors on invertebrates (i.e. it is not a stressor-specific system). The STAR_ICMi is directly calculated in the form of Ecological Quality Ratio (EQR), in accordance with WFD requirements for classification systems.</p> <p>Three aspects of the used methodology to derive class boundaries have to be considered for intercalibration purposes and to check compliancy with normative definitions:</p> <ul style="list-style-type: none"> a) the sampling technique b) the calculation formula c) the conversion of STAR_ICMi values into quality judgement (i.e. class boundaries setting). <p>a) The data used for the Intercalibration exercise were collected by using two different, standard sampling methods. Part of the data were collected with the IBE sampling technique (APAT-IRSA/CNR, 2004). It consists in sampling along 1-2 transects across the river, depending on river type, and to collect invertebrates from all major micro-habitats occurring. A preliminary check of taxa found is done in the field, so that the possible absence of taxa which are expected in unaltered conditions can be verified with integrative sampling. A minimum number of specimens, different for each taxon, must be collected to consider valid the taxon for the computation. When a taxon is accepted, three abundance classes are usually reported for the collected taxa: Present, Abundant and Dominant. Such classes are interpreted in terms of relative abundance.</p> <p>For the other samples, the AQEM approach, as described in Buffagni et al. (2002, 2004) and Hering et. al. (2004) was adopted. The method for the macroinvertebrate collection was a 'multi habitat sampling' procedure. Twenty or ten individual samples (see single types for details) are distributed according to microhabitats occurrence in the river, taken and merged into a 'site' sample. An open Surber sampler is used to collect macroinvertebrates (area 0.05 or 0.01 m²; mesh size 0.5 mm). All samples are collected in a quantitative way i.e. all specimens are picked up and brought to the lab for identification. In some cases for particularly abundant taxa, sub-sampling in the field can be used.</p>
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b) the calculation formula

The STAR_ICMi is a multi-metric index and is composed of six metrics, which account for the main aspects present in the WFD Normative definitions (see below): ASPT, $\text{Log}_{10}(\text{sel_EPTD}+1)$, 1-GOLD, N-taxa, EPT and Shannon-Weiner diversity. The ICMi value is calculated by the sum of all the ICMs, after attributing a weight to each metric. Hereafter, the list and category of each metric is provided (Table 1). After their normalization, the metrics are combined into the ICM index. Metrics are grouped into three groups, providing information on three major response areas: Tolerance, Abundance/Habitat and Richness/Diversity. A different weight is attributed to the metrics within each group, giving greater importance to the metrics based on the whole community (Buffagni et al., 2004). To obtain the final multimetric score, the same weight is attributed to each of the three metric groups (0.333).

Table 1.

Intercalibration Common Metrics (ICMs) used in the STAR ICMi

Information type	Metric type	Metric name	Taxa considered in the metric	Literature reference	weight
Tolerance	Index	ASPT	Whole community (Family level)	e.g. Armitage et al., 1983	0.333
Abundance/ Habitat	Abundance	$\text{Log}_{10}(\text{Sel_EPTD} + 1)$	Log(sum of Heptageniidae, Ephemeridae, Leptophlebiidae, Brachycentridae, Goeridae, Polycentropodidae, Limnephilidae, Odontoceridae, Dolichopodidae, Stratiomyidae, Dixidae, Empididae, Athericidae & Nemouridae)	Buffagni et al., 2004; Buffagni & Erba, 2004	0.266
	Abundance	1-GOLD	1 - (relative abundance of Gastropoda, Oligochaeta and Diptera)	Pinto et al., 2004	0.067
	Taxa number	Total number of Families	Sum of all Families present at the site	e.g. Ofenböck et al., 2004	0.167
Richness and Diversity	Taxa number	number of EPT Families	Sum of Ephemeroptera, Plecoptera and Trichoptera taxa	e.g. Ofenböck et al., 2004; Böhmer et al., 2004.	0.083
	Diversity index	Shannon-Wiener diversity index	$D_{S-W} = - \sum_{i=1}^s \left(\frac{n_i}{A} \right) \cdot \ln \left(\frac{n_i}{A} \right)$	e.g. Hering et al., 2004; Böhmer et al., 2004.	0.083

c) Accordingly to the WFD requirements, the STAR ICMi class boundaries here presented for High/Good and Good/Moderate status are type-specific. See next paragraphs for details on technical options used to set class boundaries.

	<p><u>Selection of Reference sites for the IC exercise</u></p> <p>The selection of reference sites was done according to REFCOND Guidance criteria (REFCOND criteria table was provided on 30 May 2006) and is based on pressure analysis, which included information on: water chemistry, (hydro)-morphology, general degradation, land use.</p> <p><u>Principles of the classification</u></p> <p>The used approach and thus the proposed values satisfy the requirements of the WFD: type-specific adaptation of reference conditions, use of an EQR scale, REFCOND approach for setting class boundaries. As far as normative definitions in terms of kind of information provided for invertebrates are concerned, i.e. ratio sensitive/insensitive taxa, diversity and abundance, the STAR_ICMi index fully guarantees for WFD compliancy (Buffagni et al., 2005; Wasson & Buffagni, 2005). Also, the sensitivity of the STAR_ICMi can comply with normative definitions in terms of evaluation of: "slight deviation" of taxa richness from reference conditions; presence of sensitive taxa; presence of major taxonomic groups. In Appendix, the relationship between the quality classes based on the proposed STAR_ICMi values and each of the composing biological metrics are shown for Reference sites and different quality classes (Box&Whiskers plots). The same principles were applied to all IC river types in Italy.</p> <p><u>Boundary setting approach</u></p> <p><i>Definition of High /Good boundary</i></p> <p>For each type, the High/Good class boundary was set to correspond to the 25th percentile of STAR_ICMi values observed at reference sites, which is considered to be a simple approach in line with WFD requirements → REFCOND approach.</p> <p><i>Definition of Good/Moderate boundary</i></p> <p>The Good/Moderate class boundary was set accordingly to the following procedure.</p> <ol style="list-style-type: none"> 1. The G/M boundary is set to correspond to the H/G boundary (see above) multiplied by 0.75. I.e., the range covered by STAR_ICMi values comprised between 0 and the 25th percentile of STAR_ICMi observed at reference sites is partitioned into 4 equally spaced classes, Good status being the highest in terms of STAR_ICMi. A 25% deviation from reference sites value is assumed to be, in general terms, a slight deviation → REFCOND approach. 2. STAR_ICMi values of samples classified according to boundaries set at 1) are tested against an independent, benchmark dataset, the AQEM/STAR Benchmark dataset (as described in Buffagni et al., 2005; 2006; 2007; Buffagni & Erba, 2006) and: <ol style="list-style-type: none"> 2a. No statistically significant differences are found: the G/M boundary set in 1) is maintained, or 2b. Statistically significant differences are found: a second potential value for the boundary is calculated, which would remove such differences. An intermediate value comprised between the two possible boundary values defined in 1) and 2b) is selected as the final G/M boundary.
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	<p>Point 1) for preliminary H/G and G/M boundary setting does not need any further explanation, because it simply makes use of a percentile and of an arithmetical separation into 4 equal classes. Nonetheless, such a simple option risks generating numerical results (i.e. boundaries) that are not ecologically sound. That's why point 2) checking was adopted (see also Buffagni & Furse, 2006).</p> <p>Point 2) does require some more clarification, which is reported hereafter. To support a better trans-GIG comparability, due to the better overall performance and to existing literature, out of the pool of ICMi used In the Alpine, Central and Med GIGs, Italy selected the STAR ICMi (Buffagni et al., 2005; 2006) and used it in statistical testing for deriving a second value, for the G/M boundary. Firstly, the STAR_ICMi value for each invertebrate sample is calculated. A statistical comparison is then executed between the STAR_ICMi values found in the AQEM/STAR benchmark dataset - which is assumed to enclose WFD compliant classifications (Buffagni & Erba, 2006) - and the same observed in the IC river dataset under investigation for the Good status class as defined by using point 1) approach. It must be noted that the AQEM/STAR benchmark dataset contains data from many European countries and thus its use represents an attempt to directly relate Italian class boundaries to International, independent data. The procedure is explained in details in Buffagni et al., 2005; 2006; 2007.</p> <p>If samples do not significantly differ from benchmark ones (2a), the boundary set in 1) according to the REFCOND approach is maintained.</p> <p>If samples significantly differ from benchmark ones (2b) i.e they show values lower than benchmark data, the G/M boundary obtained in point 1) is moved up and corresponding samples removed from the Good class (i.e. those resulting below the new threshold value), until no more statistically significant differences are observed. Finally, a single boundary value within the range defined by values calculated at steps 1) and 2b) is selected</p> <p>The ecological soundness of the selected boundaries, H/G and G/M, was then validated, in terms of Normative definitions, by looking at the distribution of WFD compliant metrics values as a function of the final classification. In particular circumstances, the boundary set can be slightly adjusted according to other information available. A few examples are reported for each stream type, which support the adherence of the classification to Normative definitions for invertebrates.</p> <p>In Annex 1, summary information on the Italian Mediterranean datasets used for the IC process is reported for R-M1, R-M2, R-M4 and R-M5.</p> <p><u>Future revision of the classification</u></p> <p>New samples are being collected at new reference sites all over Italy, for all GIGs and types, during 2007 and 2008. This will possibly supply a larger set of invertebrate and pressure data. Thus, also in relation to the results of the ongoing Intercalibration activity for other Italian stream types (i.e. from the Central and Alpine GIGs) and to the definition of an improved typology for Italian rivers, some refinements of boundaries might be required and/or desirable.</p> <p>The boundaries proposed here are fully in line with the WFD requirements in the considered IC stream types. Then, it seems that an important correction of the pre-WFD system of classification based on aquatic invertebrate has been arranged, which is bringing Italy into a consistent accomplishment of WFD constraints.</p>
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Criteria for Boundary Setting	High/Good boundary	Good/Moderate boundary
Taxonomic composition and abundance (see Appendix below)	The Total Number of taxa, the number of EPT taxa, 1-GOLD, and Sel EPTD_taxa show - in High status samples - values that correspond totally or nearly totally to those observed at reference sites.	For the same metrics, the deviation from reference sites values is slight. (see Appendix below)
Ratio of disturbance sensitive to insensitive taxa (see Appendix below)	The sensitive to insensitive taxa ratio is reflected by the ASPT metric, by the presence/absence of indicator taxa (Sel EPTD_taxa and 1-GOLD) and by the number of EPT taxa. In High status samples, they show values that correspond totally or nearly totally to those observed at reference sites.	For the same metrics, the deviation from reference sites values is slight (see Appendix below)
Level of diversity (see Appendix below)	The diversity is reflected by the Total Number of taxa, number of EPT taxa and by the Shannon-Wiener metric. In High status samples, they show values that correspond to those observed at reference sites (they are even higher).	For the same metrics, the deviation from reference sites values is slight (see Appendix below)
STAR ICMi, in general	<p>The High/Good boundary was set according to the procedure described in the text above, which is performed on the index values after the combination of the composing metrics. Even the relationship of single metrics included in the index show a good discriminatory power among quality classes (see Appendix).</p> <p>The REFCOND approach was used to set the High/Good class boundary i.e. 25th %ile value of REF samples</p>	<p>The Good/Moderate boundary was set according to the procedure described in the text above, which is performed on the index values after the combination of the composing metrics. Even the relationship of single metrics included in the index show a good discriminatory power among quality classes (see Appendix).</p> <p>The REFCOND approach was used to set class boundary (equal classes repartition starting from the 25th %ile value of REF samples) and it was further validated by comparing to totally independent, benchmarking system (i.e. AQEM/STAR European dataset)</p>

Type-specific Information

Part 2.

R-M1 IC type

Dataset used

The invertebrate and pressure data used for R-M1 were collected and provided by CNR-IRSA. Invertebrate samples were collected within the framework of the EU co-funded AQEM project (Buffagni et al., 2001; 2002; 2004; Hering et al., 2003) and cover the full degradation gradient observed in the area (Campania, Salerno Province, Southern Italy) i.e. from Bad status to Reference sites. In total, 30 samples collected in 2000/2001 are being used, including 8 samples from 3 Reference sites. Reference sites were selected/screened on the basis of the REFCOND criteria, with the more in-depth suggestions provided by CB_GIG.

Class boundary results

In Table M1.1, the calculated values by 1), 2) and final boundaries (STAR_ICMi) for all classes are provided.

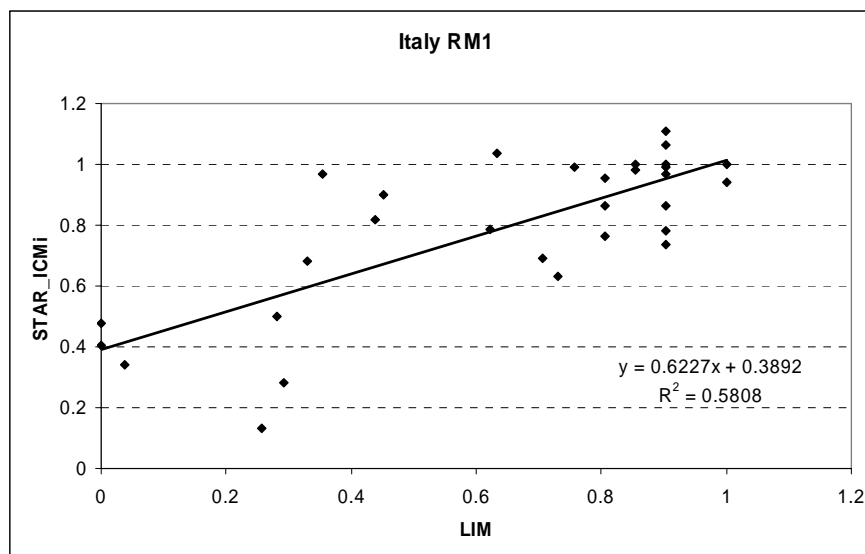
Table M1.1. Italy R-M1. EQR scale. Boundary values reported are the lowest limit of each quality class.

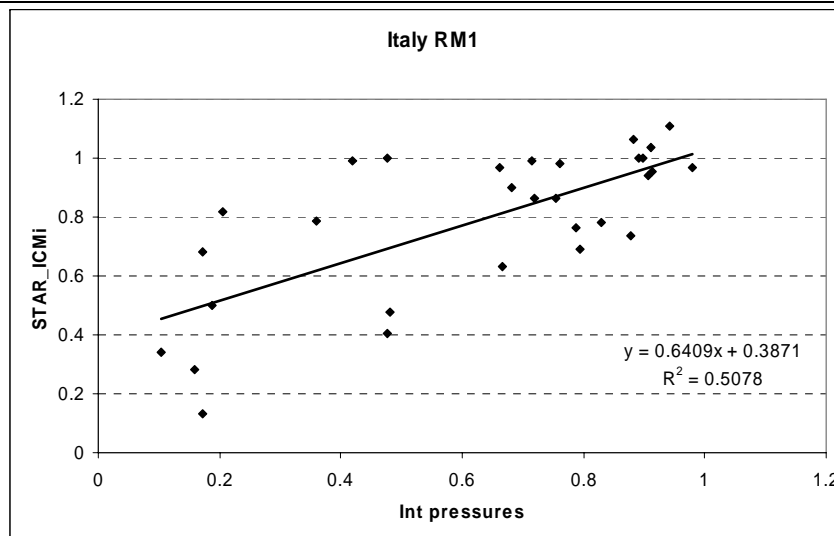
	STAR_ICMi values according to REFCOND approach	STAR_ICMi values after testing with benchmark	Final STAR_ICMi boundaries	final decision criteria
High/Good	0.966	0.966	0.966	REFCOND and benchmark testing
Good/Moderate	0.724	0.724	0.724	REFCOND and benchmark testing
Moderate/Poor	0.483	nc	0.483	REFCOND
Poor/Bad	0.241	nc	0.241	REFCOND

After setting class boundaries with the REFCOND approach, no differences were found with the AQEM/STAR benchmark dataset, for both High and Good status classes. The obtained boundary values can then be confirmed for classes H/G and G/M. The ecological soundness of the two selected boundaries, H/G and G/M, was further validated, in terms of Normative definitions, by looking at the distribution of each STAR_ICMi WFD compliant metrics values in the different quality classes. The results reported in Appendix support the adherence of the classification to Normative definitions for invertebrates.

Relationship between STAR_ICMi and pressure indices (detail)

The relationship between the STAR_ICMi and pressures was investigated because the STAR_ICMi is adopted as the National reference for intercalibration purposes in Italy for the Med_GIG types. The relationship between Chemical quality (LIM) and Integrated pressures versus the STAR_ICMi are shown below.





R-M2 IC type

Dataset used

The invertebrate and pressure data used for R-M2 were collected and provided by Emilia-Romagna EPA (Reggio Emilia and Piacenza Department). Invertebrate samples were collected for standard monitoring purposes at the province scale and cover the full degradation gradient observed in the area (mainly Piacenza Province, Northern Italy) i.e. from Bad status to Reference sites. In total, 242 samples from 32 sites collected over a period of ca 6 years (2000 to 2006) were used, including 7 samples from 2 Reference sites.

Class boundary results

In Table M2.1, the calculated values by 1) i.e. the REFCOND approach, as explained above, and 2) final boundaries (STAR_ICMi) for all classes are provided.

Table M2.1. Italy R-M2. EQR scale. Boundary values reported are the lowest limit of each quality class.

		STAR_ICMi values according to REFCOND approach	Final STAR_ICMi boundaries	STAR_ICMi values after testing with benchmark	final decision criteria
High/Good	25%ile Ref	0.978	0.938	0.938	R-M4 boundary and benchmark testing
Good/Moderate		0.733	0.703	0.703	R-M4 boundary and benchmark testing
Moderate/Poor		0.489	0.469	nc	R-M4 boundary
Poor/Bad		0.244	0.235	nc	R-M4 boundary

After normalizing and setting the H/G class boundary with the explained approach, the other class boundaries were set by dividing the range into four equally spaced classes. No significant differences were observed for the Good status class between benchmark and Italian R-M2 data. Later, the obtained boundary values were equalled to the boundaries proposed for R-M4 (see below). Many R-M4 samples were infact collected in the upstream river reaches where R-M2 samples were collected. It was thus considered important to keep for these two river types the same boundaries. After this minor adjustment, no differences were anyway found comparing to the benchmark dataset (see Table M2.1). The ecological soundness of the two selected boundaries, H/G and G/M, was further validated, in terms of Normative definitions, by looking at the distribution of each STAR_ICMi WFD compliant metrics values in the different quality classes. The results reported in Appendix support the adherence of the classification to Normative definitions for invertebrates.

R-M4 IC type

Dataset used

The invertebrate and pressure data used for R-M4 were collected and provided by CNR-IRSA. Invertebrate samples were collected within the framework of the EU co-funded AQEM project (Buffagni et al., 2001; 2002; 2004; Hering et al., 2003) and cover the full degradation gradient observed in the area (Emilia-Romagna, Northern Italy) i.e. from Moderate status to Reference sites. In total, 33 samples collected in 2000/2001 are being used, including 6 samples from 3 Reference sites. Reference sites were selected/screened on the basis of the REFCOND criteria, with the more in-depth suggestions provided by CB_GIG.

Class boundary results

In Table M4.1, the calculated values by 1), 2) and final boundaries (STAR_ICMi) for all classes are provided.

Table M4.1.taly R-M4. EQR scale. Boundary values reported are the lowest limit of each quality class.

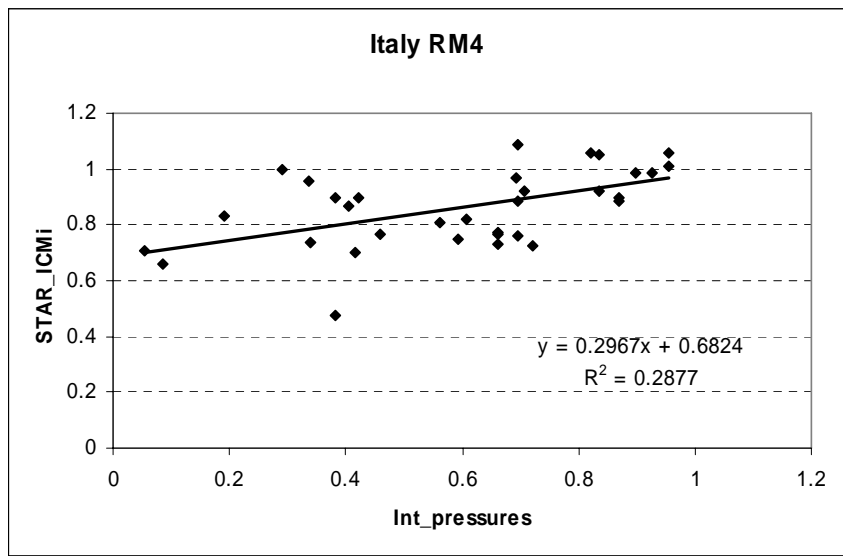
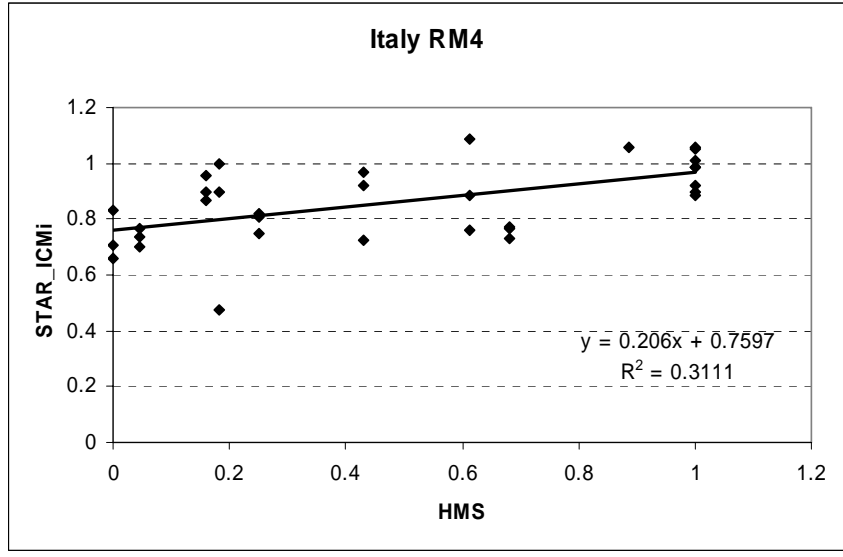
		STAR_ICMi values according to REFCOND approach	STAR_ICMi values after testing with benchmark	Final STAR_ICMi boundaries	final decision criteria
High/Good	25%ile Ref	0.938	0.938	0.938	REFCOND and benchmark testing
Good/Moderate		0.703	0.703	0.703	REFCOND and benchmark testing
Moderate/Poor		0.469	nc	0.469	REFCOND
Poor/Bad		0.235	nc	0.235	REFCOND

After setting class boundaries with the REFCOND approach, no differences were found with the AQEM/STAR benchmark dataset, for both High and Good status classes. The boundary values obtained by REFCOND approach can then be confirmed for classes H/G and G/M.

The ecological soundness of the two selected boundaries, H/G and G/M, was further validated, in terms of Normative definitions, by looking at the distribution of each STAR_ICMi WFD compliant metrics values in the different quality classes. The results reported in Appendix support the adherence of the classification to Normative definitions for invertebrates.

Relationship between STAR_ICMi and pressure indices (detail)

The relationship between the STAR_ICMi and pressures was investigated in further detail, because the STAR_ICMi is adopted as the National reference for intercalibration purposes in Italy for the Med_GIG types. The relationship between Morphological quality (HMS) and Integrated pressures versus the STAR_ICMi are showed below.



R-M5 IC type

Dataset used

The invertebrate and pressure data used for R-M5 were collected and provided by CNR-IRSA. Invertebrate samples were collected within the framework of the MICARI project (Erba et al., 2004), co-funded by the Italian Ministry for University and Research, and cover the full degradation gradient observed in the area (Sardinia) i.e. from Bad status to Reference sites. In total, 25 samples collected in 2003/2004 are being used, including 5 samples from 3 Reference sites. Reference sites were selected/screened on the basis of the REFCOND criteria, with the more in-depth suggestions provided by CB_GIG. Summer (dry season) samples were excluded from the analysis.

The study sites belong to temporary rivers. Nonetheless, their transitory character can show a great variation in the length of the dry period, which can fluctuate between a few weeks and some months, according to climate traits of the year. When the dry season is very short or certain years even absent, rivers of this type are close to IC R-M1 rivers.

Class boundary results

In Table M5.1, the calculated values by 1), 2) and final boundaries (STAR_ICMi) for all classes are provided.

Table M5.1. Italy R-M5. EQR scale. Boundary values reported are the lowest limit of each quality class.

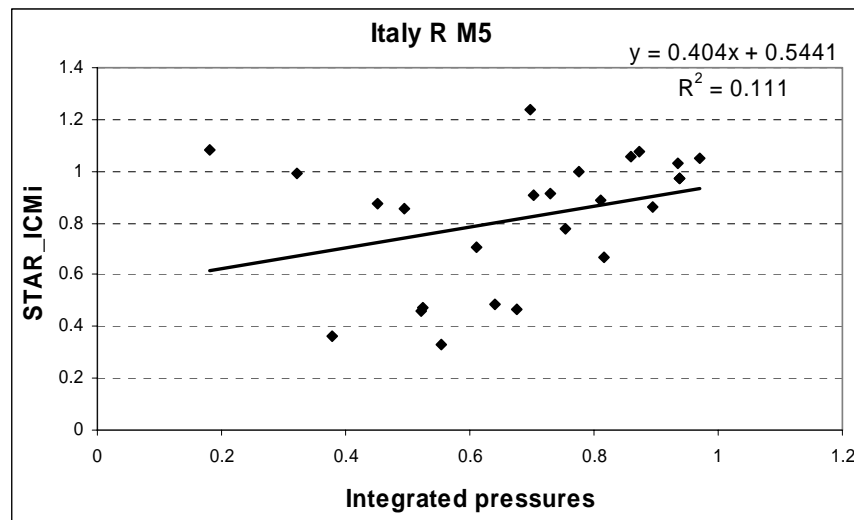
		STAR_ICMi values according to REFCOND approach	STAR_ICMi values after testing with benchmark	Final STAR_ICMi boundaries	final decision criteria
High/Good	25%ile Ref	0.972	0.972	0.972	REFCOND and benchmark testing
Good/Moderate		0.729	0.729	0.729	REFCOND and benchmark testing
Moderate/Poor		0.486	nc	0.486	REFCOND
Poor/Bad		0.243	nc	0.243	REFCOND

After setting class boundaries with the REFCOND approach, no differences were found with the AQEM/STAR benchmark dataset, for both High and Good status classes. The boundary values obtained with the REFCOND approach can then be confirmed for classes H/G and G/M.

The ecological soundness of the two selected boundaries, H/G and G/M, was further validated, in terms of Normative definitions, by looking at the distribution of each STAR_ICMi WFD compliant metrics values in the different quality classes. The results reported in Appendix support the adherence of the classification to Normative definitions for invertebrates.

Relationship between STAR_ICMi, M5 Qualitative ICMi and pressure indices (detail)

The relationship between Integrated pressures and STAR_ICMi (quite poor) is shown. This is a general problem for temporary rivers, where natural variability can mask the effect of ecological quality degradation and *vice versa*.



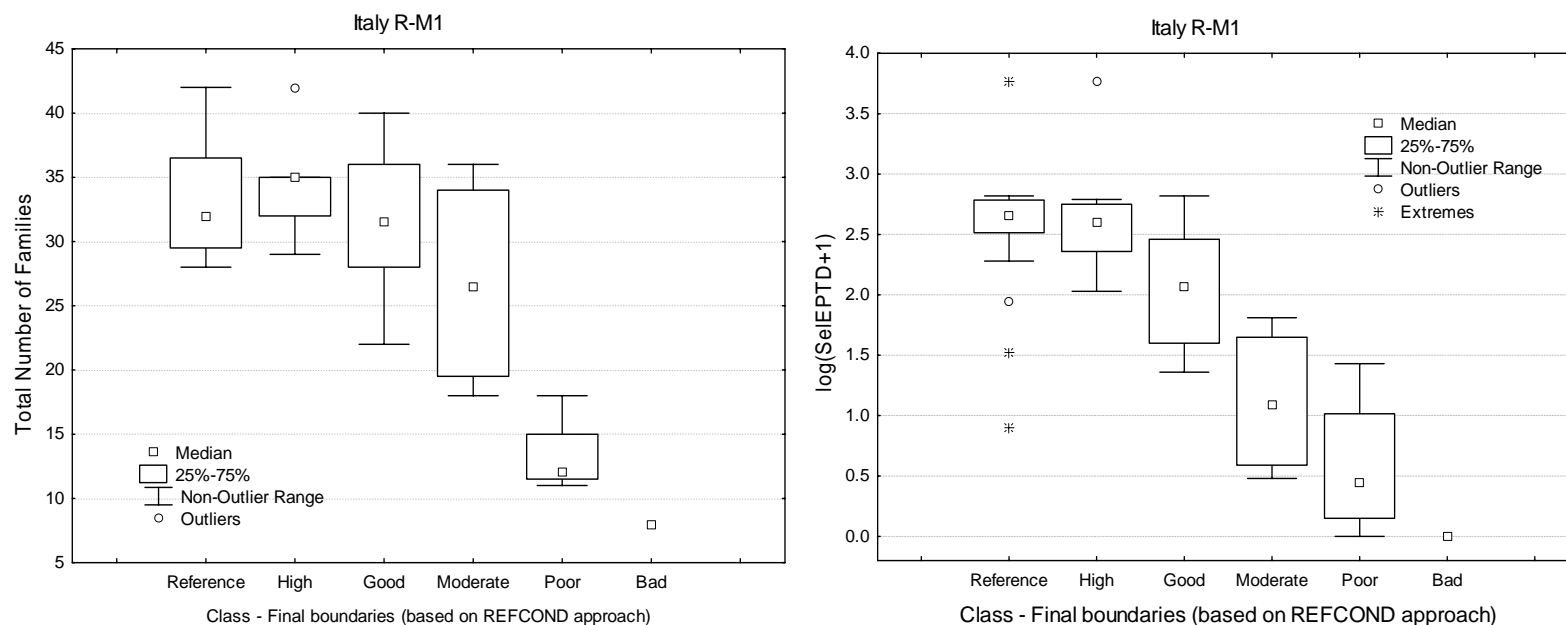
R-M1 Appendix (IT)

To show more in detail the response of the considered biological metrics, which are able to fulfil the WFD definitions for aquatic invertebrates in rivers, to the STAR_ICMi classification (i.e. boundaries), they are shown below, according to the main definition categories in the WFD. The distribution of values for each metric in the 5 Ecological Status classes based on the STAR_ICMi boundaries and at Reference sites is shown in the form of Box&Whiskers plots .

Taxonomic composition and abundance

The Total Number of taxa (here Families) found in a sample can be considered one of the major indicators for taxonomic composition (see figure below, left). The median Number of Families observed at REF and Good status sites is the same (32), with a weakly larger dispersion of samples to lower values of the Good samples. This is undoubtedly a very slight change in the composition of the invertebrate community.

The EPT taxa metric as well contributes to taxonomic composition of the community (see graph in 'Ratio of disturbance sensitive to insensitive taxa').

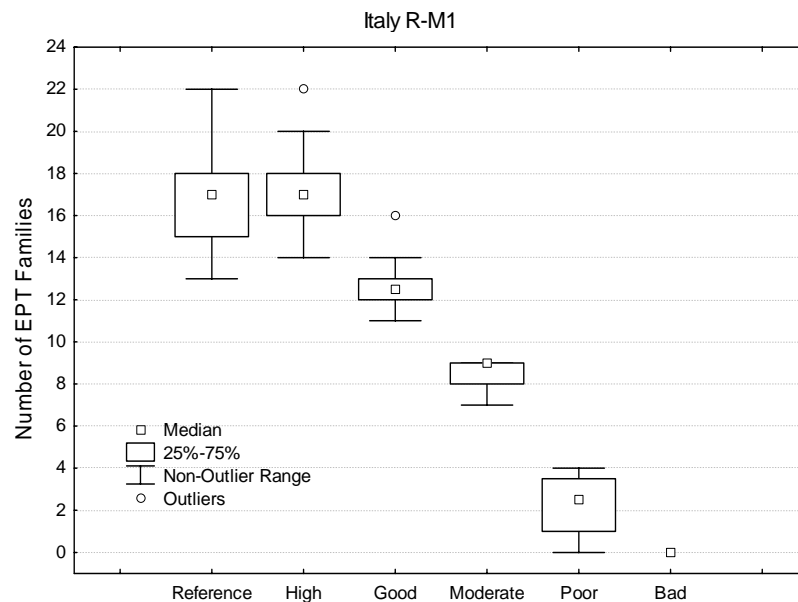


The abundance-based metric Sel EPTD_taxa accounts for the invertebrate abundance, taxonomic composition and presence of sensitive taxa (above, right). The shift from ca 2.6 (REF) to ca 2 (Good status) in Sel EPTD_taxa is considered a slight change in the composition and abundance of the invertebrate community. In fact, the taxa enumerated in this metric are much less abundant in Moderate and lower quality classes (i.e they are sensitive taxa, expected to disappear at altered sites). Abundance (in terms of abundance classes) is also used in Shannon-Wiener index calculation (see 'Level of diversity') and in 1-GOLD (see below).

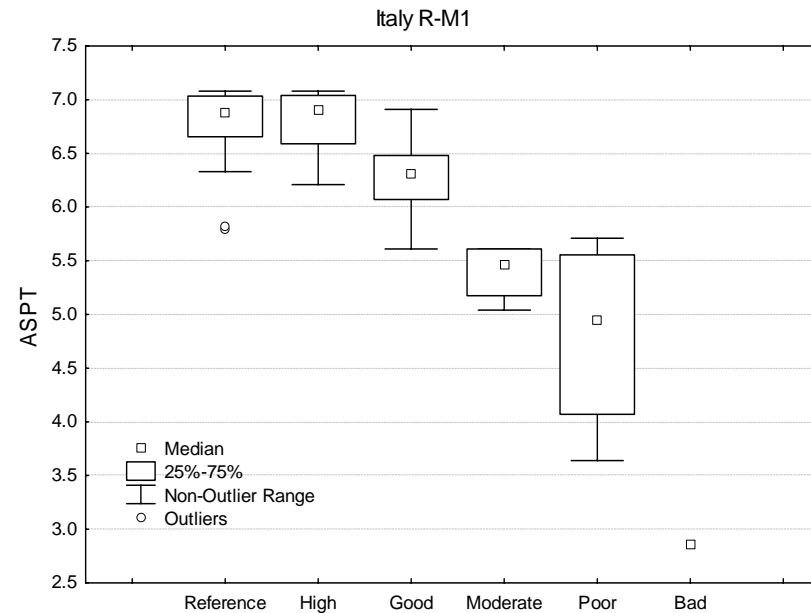
Ratio of disturbance sensitive to insensitive taxa (and missing major taxonomic groups)

EPT-Taxa can be seen as the most sensitive taxonomic groups in Med river types. A positive value of this metric indicates that at least one of the three most sensitive major taxonomic groups is present in the community.

In the Italian R-M1 dataset, a minimum of 11 EPT Families is encountered at Good status (below, left). The disappearance of EPT Families is only experienced once in Poor and in Bad status. It appears than clearly how the most sensitive major taxonomic groups are always present in Good status samples according to the proposed boundaries.



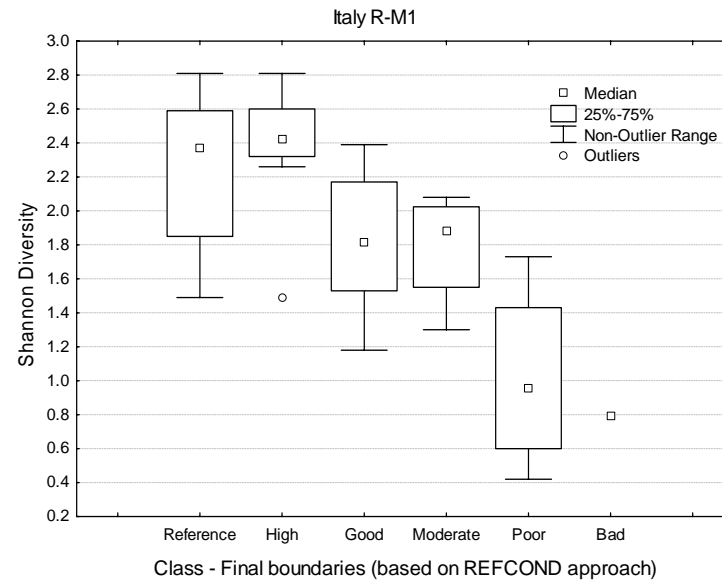
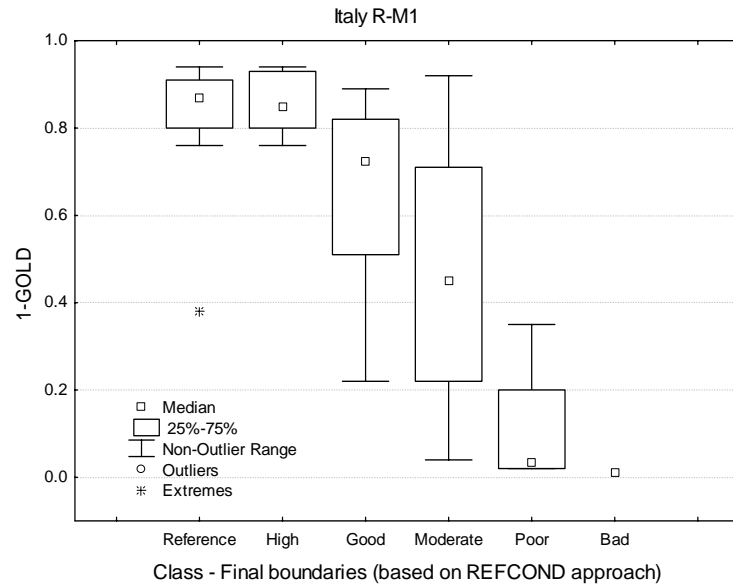
Class - Final boundaries (based on REFCOND approach)



Class - Final boundaries (based on REFCOND approach)

The ASPT metric is also shown, which undoubtedly accounts for the Ratio of disturbance sensitive to insensitive taxa (figure above, right). For the Good status class, it shows a slight deviation from the level observed at Reference sites (1 unit of variation circa).

1-GOLD is quite informative as well in this stream type (below, left).

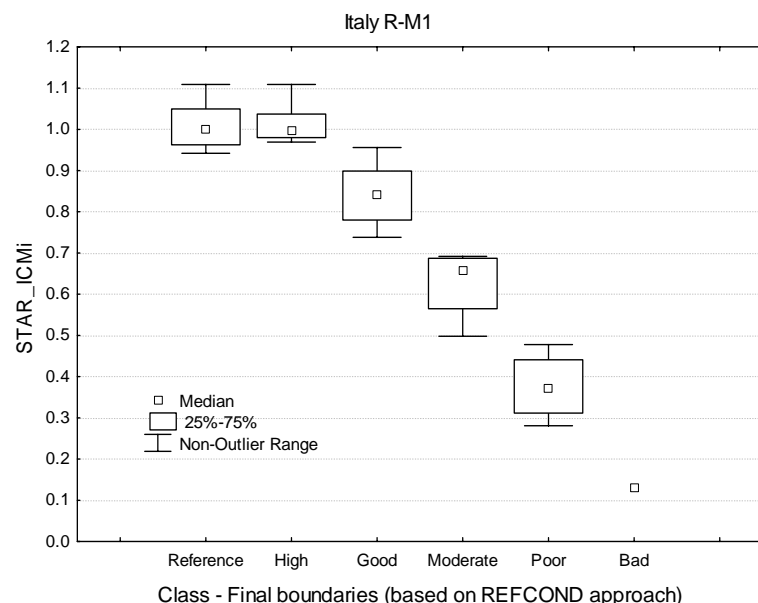


Level of diversity

The level of diversity of invertebrate taxa is considered in the STAR_ICMi in terms of Shannon-Wiener diversity index (see graph above, right). The variation of this metric in Good status samples shows slight signs of alteration from reference sites levels (Median of REF: 2.38; Median of Good status: > 1.8, with a range going to values of 0.4).

Diversity, in terms of Richness of the community, is presented in 'Taxonomic composition and abundance' (Total Number of Families).

Overall trend of STAR_ICMi classes



The distribution of the values of the STAR_ICMi index (which incorporates all the metrics shown above) in the 5 Ecological Status classes is shown to describe the general trend of values into quality classes and at REF sites.

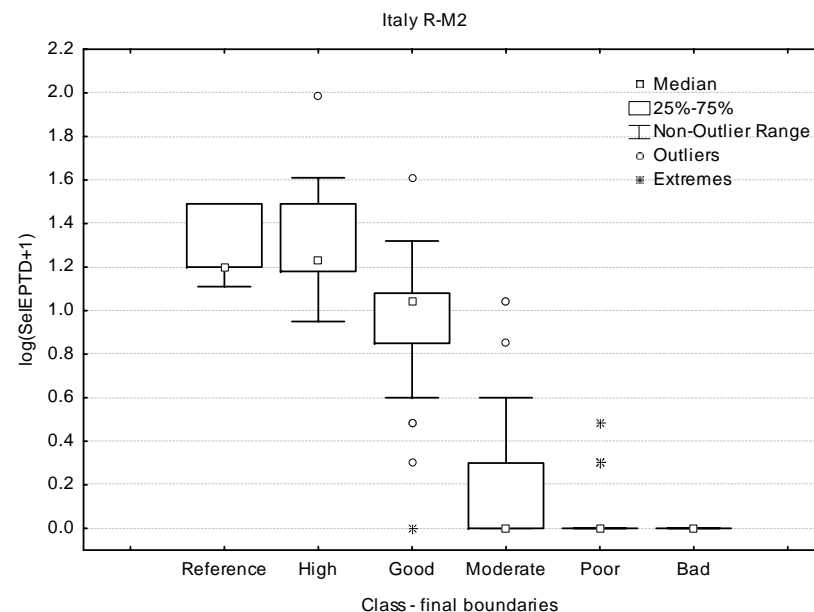
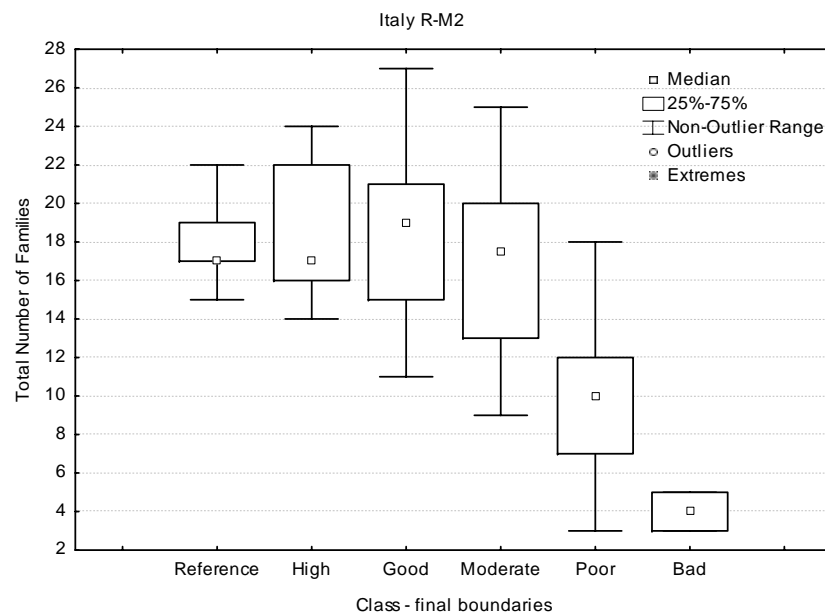
R-M2 Appendix (IT)

To show more in detail the response of the considered biological metrics, which are able to fulfil the WFD definitions for aquatic invertebrates in rivers, to the STAR_ICMi classification (i.e. boundaries), they are shown below, according to the main definition categories in the WFD. The distribution of values for each metric in the 5 Ecological Status classes based on the STAR_ICMi boundaries and at Reference sites is shown in the form of Box&Whiskers plots .

Taxonomic composition and abundance

The Total Number of taxa (here Families) found in a sample can be considered one of the major indicators for taxonomic composition (see figure below, left). For this metric the value gets at Good status is even higher than the one get at Reference and High status. It is anyway known from literature as slight enrichment in nutrients concentration can lead to an improvement in the number of families. The improvement is in fact in the number of non-sensitive families (see below).

The EPT taxa metric as well contributes to taxonomic composition of the community (see graph in 'Ratio of disturbance sensitive to insensitive taxa').



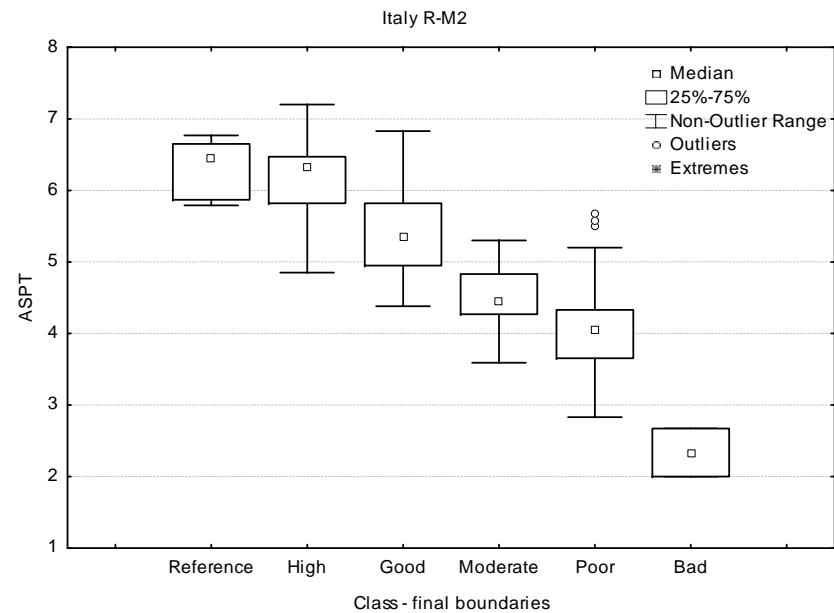
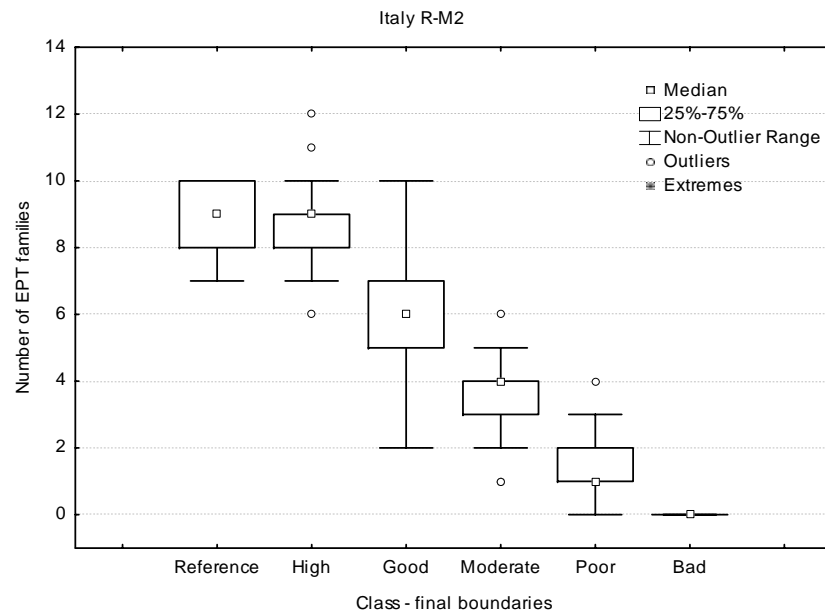
The genuine, abundance-based metric included in the STAR_ICMi i.e. Sel EPTD_taxa, clearly accounts for abundance of aquatic invertebrates (see above, right). The shift from 1.2 (Ref) to 1.05 (G) in Sel EPTD_taxa (median values) is considered a slight change in the composition and abundance of the invertebrate community. In fact, the taxa enumerated in this metric are absent in Bad and Poor (with two exception only) status samples i.e they are sensitive taxa, expected to disappear at altered sites. The metric has a great discriminatory power in R-M2.

Abundance (in terms of abundance classes) is also used in Shannon-Wiener index calculation (see 'Level of diversity') and in 1-GOLD (see below).

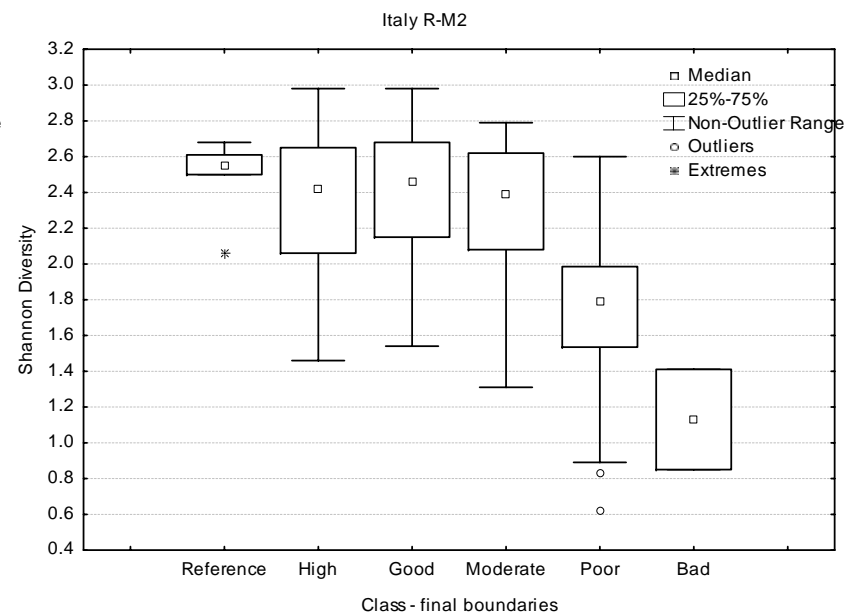
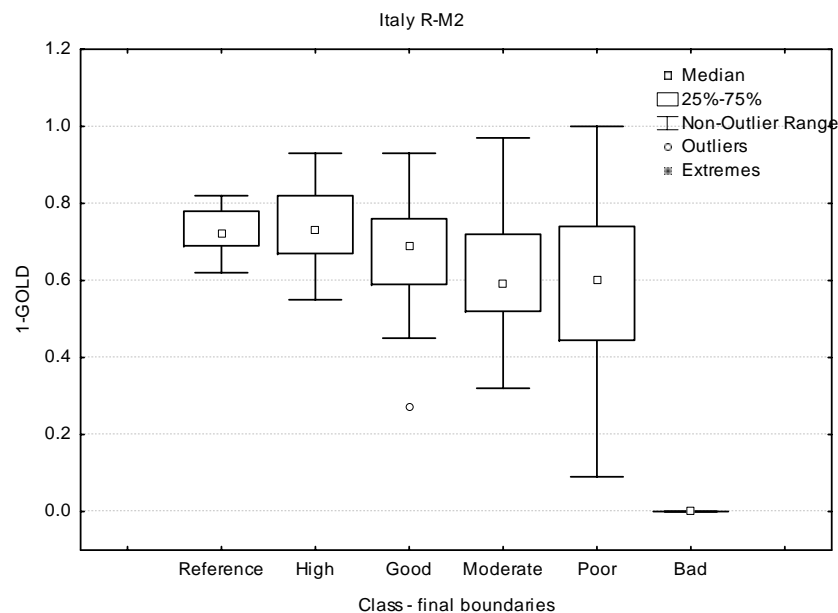
Ratio of disturbance sensitive to insensitive taxa (and missing major taxonomic groups)

EPT-Taxa can be seen as the most sensitive taxonomic groups in Med rivers types. A positive value of this metric indicates that at least one of the three most sensitive major taxonomic groups is present in the community.

In the Italian R-M2 dataset, a minimum of 2 EPT Families is encountered at Good status, with 75% of samples bearing 5 or more EPT Families (below, left). A general consideration is that the number of EPT families is generally low. The disappearance of EPT Families is experienced in 25% samples of Bad status. It appears than clearly how the most sensitive major taxonomic groups are always present in Good status samples according to the proposed boundaries.



The ASPT metric is also shown, which undoubtedly accounts for the Ratio of disturbance sensitive to insensitive taxa (figure above, right). For the Good status class, it shows a slight deviation from the level observed at Reference sites (less than 1 unit of variation). 1-GOLD seems not very informative in this stream type (below, left).

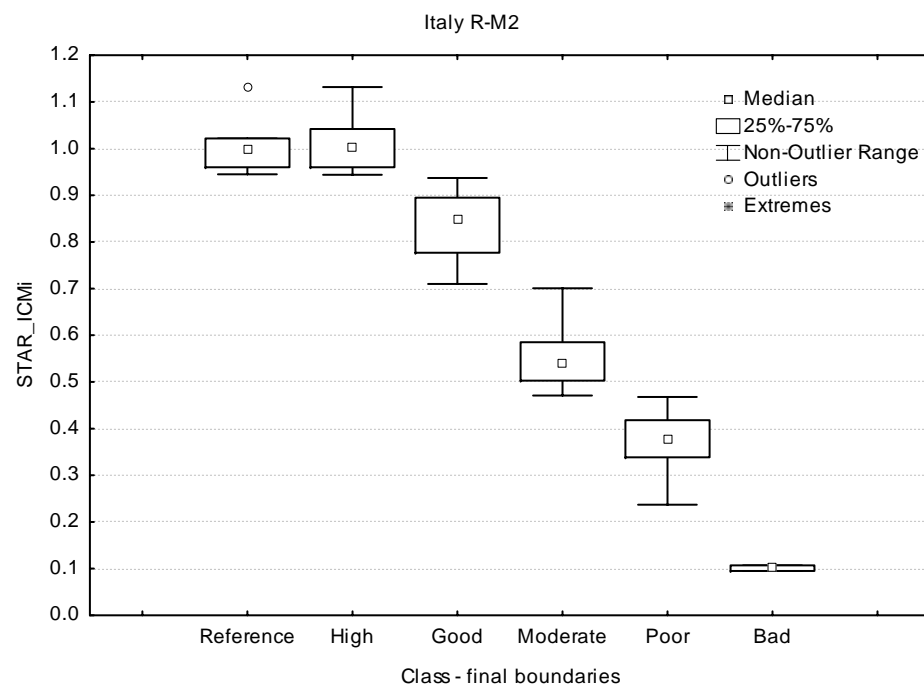


Level of diversity

The level of diversity of invertebrate taxa is here reported in terms of Shannon-Wiener diversity index (see graph above, right). This metric is not very much informative.

Diversity, in terms of Richness of the community, is presented in 'Taxonomic composition and abundance' (Total Number of Families).

Overall trend of STAR_ICMi classes



The distribution of the values of the STAR_ICM index (which incorporates all the metrics shown above) in the 6 Ecological Status classes is shown to describe the general trend of values.

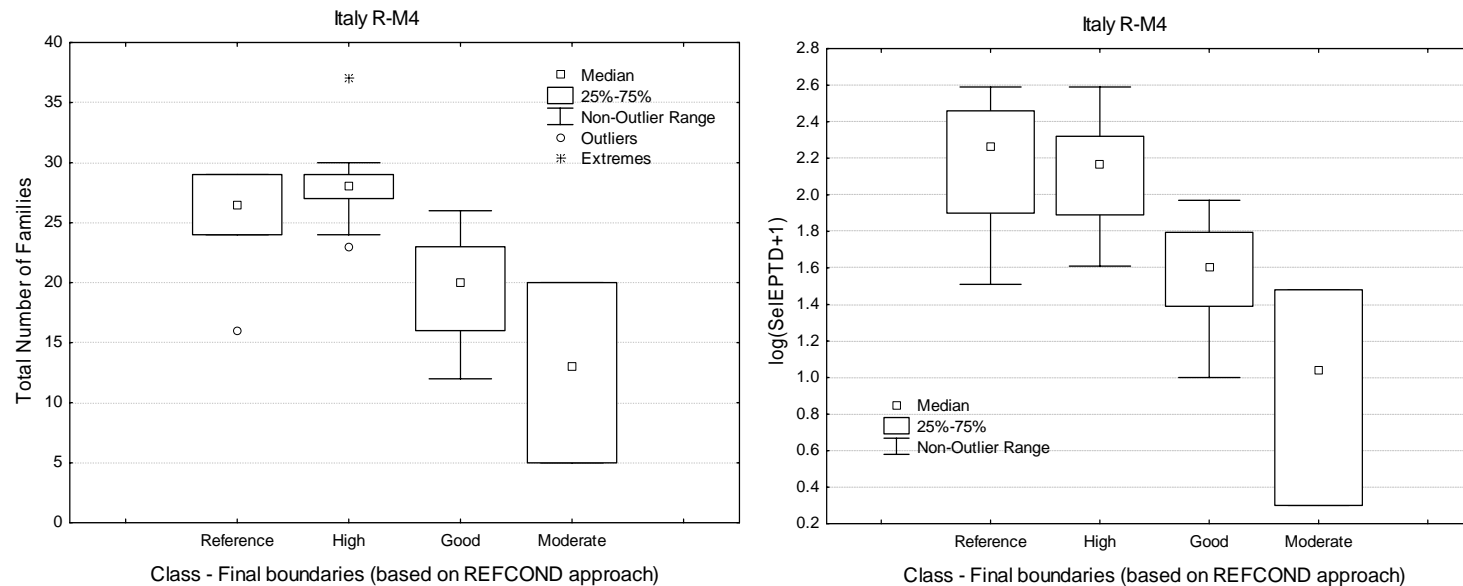
R-M4 Appendix (IT)

To show more in detail the response of the considered biological metrics, which are able to fulfil the WFD definitions for aquatic invertebrates in rivers, to the STAR_ICMi classification (i.e. boundaries), they are shown below, according to the main definition categories in the WFD. The distribution of values for each metric in the 5 Ecological Status classes based on the STAR_ICMi boundaries and at Reference sites is shown in the form of Box&Whiskers plots .

Taxonomic composition and abundance

The Total Number of taxa (here Families) found in a sample can be considered one of the major indicators for taxonomic composition (see figure below, left). The shift from 27 (REF) to 20 (Good status) in the Number of Families is considered a relatively slight change in the composition of the invertebrate community.

The EPT taxa metric as well contributes to taxonomic composition of the community (see graph in 'Ratio of disturbance sensitive to insensitive taxa').



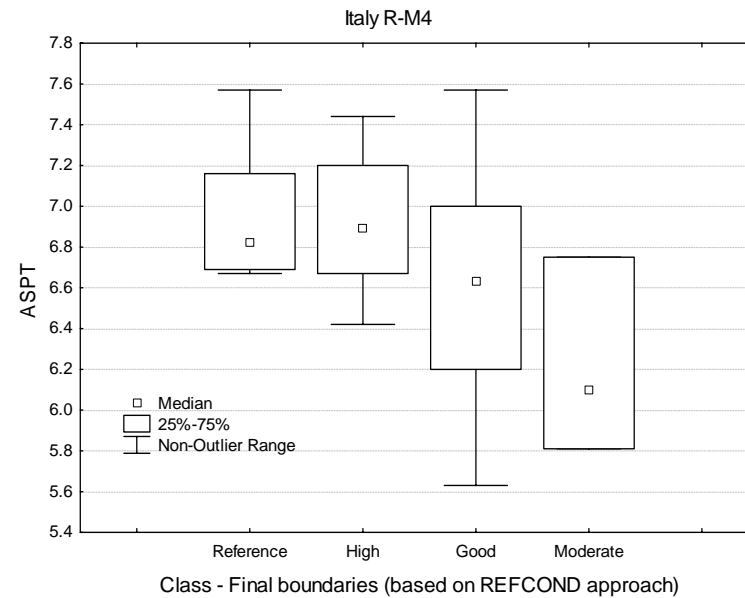
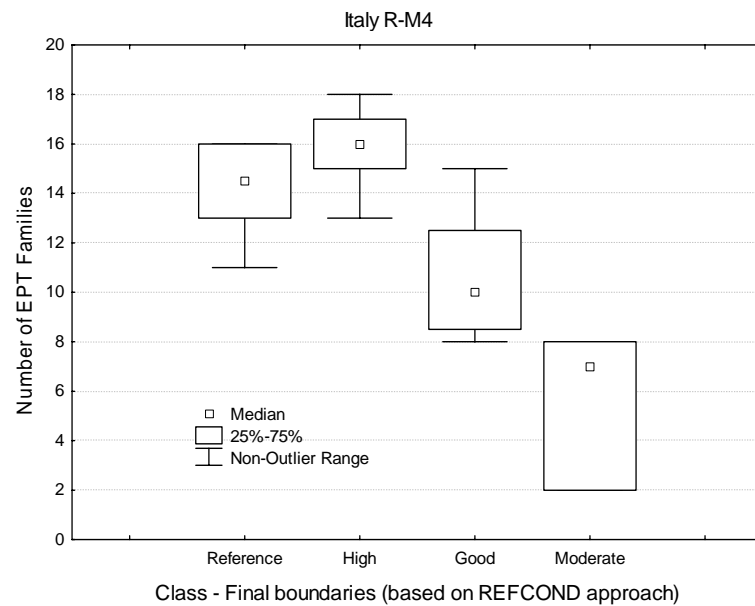
The abundance-based metric Sel EPTD_taxa accounts for invertebrate abundance (see above, right). The shift from ca 2.2 (REF) to 1.6 (Good status) in Sel EPTD_taxa is considered a slight change in the composition and abundance of the invertebrate community.

Abundance (in terms of abundance classes) is also used in Shannon-Wiener index calculation (see 'Level of diversity') and in 1-GOLD (see below).

Ratio of disturbance sensitive to insensitive taxa (and missing major taxonomic groups)

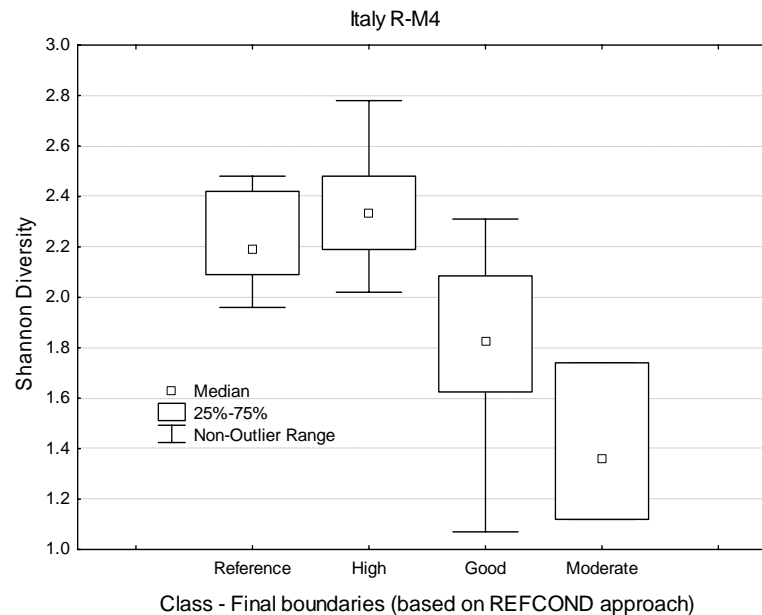
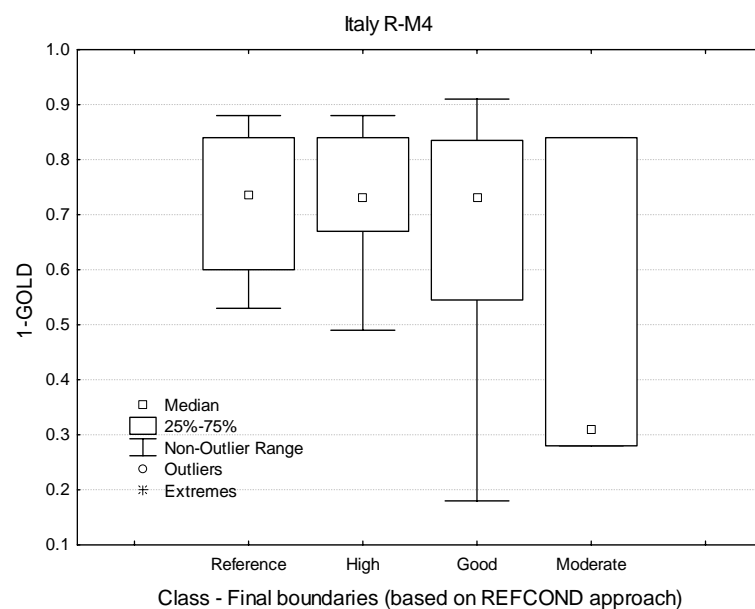
EPT-Taxa can be seen as the most sensitive taxonomic groups in Med rivers types. A positive value of this metric indicates that at least one of the three most sensitive major taxonomic groups is present in the community.

In the Italian R-M4 dataset, a minimum of 8 EPT Families is encountered at Good status (below, left). The disappearance of EPT Families is only experienced in one circumstance in Moderate status.



The ASPT metric is also shown, which undoubtedly accounts for the Ratio of disturbance sensitive to insensitive taxa (figure above, right). For the Good status class, it shows a slight deviation from the level observed at Reference sites (around 0.25 unit of variation). In the used dataset, the metric is not very well discriminating. This is presumably due to the fact that the major stressor acting is hydro-morphological degradation (i.e. no or very light organic pollution).

1-GOLD (below, left) is not informative in this stream type as well, where hydro-morphological alteration predominates.

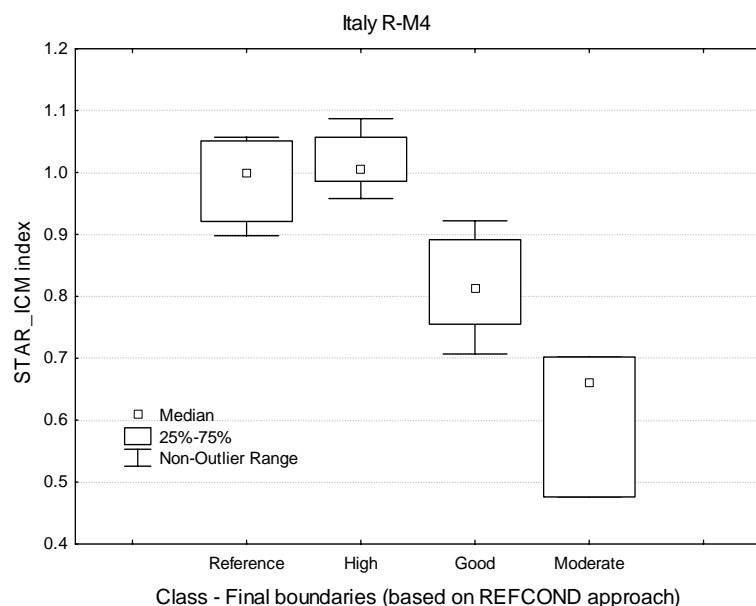


Level of diversity

The level of diversity of invertebrate taxa is here reported in terms of Shannon-Wiener diversity index (see graph below). The variation of this metric in Good status samples shows only slight signs of alteration from reference sites levels (Median of REF: 2.2; Median of Good status: >1.8, with a range going to values lower than 1.1).

Diversity, in terms of Richness of the community, is presented in 'Taxonomic composition and abundance' (Total Number of Families).

Overall trend of STAR_ICMi classes



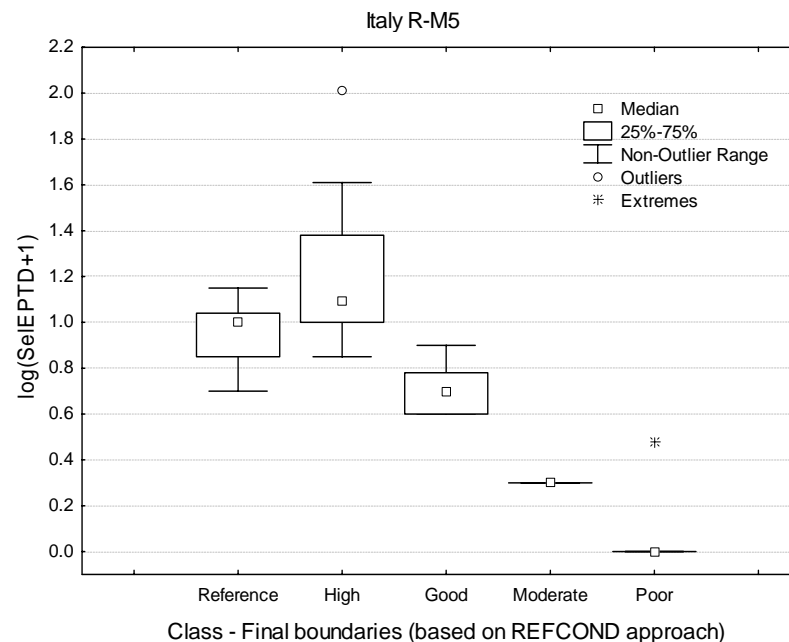
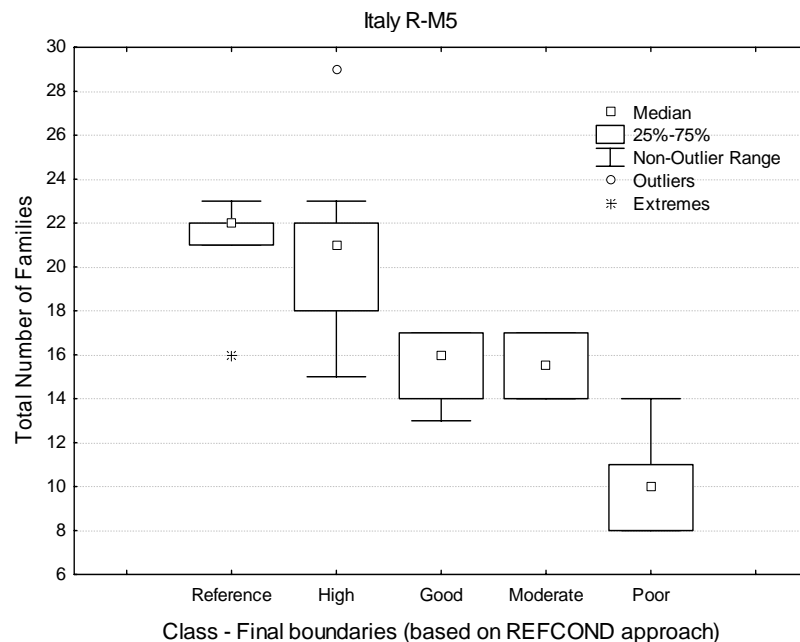
The distribution of the values of the STAR_ICM index (which incorporates all the metrics shown above) in the 5 Ecological Status classes is shown to describe the general trend of values into quality classes and at REF sites.

R-M5 Appendix (IT)

To show more in detail the response of the considered biological metrics, which are able to fulfil the WFD definitions for aquatic invertebrates in rivers, to the STAR_ICMi classification (i.e. boundaries), they are shown below, according to the main definition categories in the WFD. The distribution of values for each metric in the 5 Ecological Status classes based on the STAR_ICMi boundaries and at Reference sites is shown in the form of Box&Whiskers plots .

Taxonomic composition and abundance

The Total Number of taxa (here Families) found in a sample can be considered one of the major indicators for taxonomic composition (see figure below, left). The shift from 22 (REF) to 16 (Good status) in the Number of Families is considered a slight change in the composition of the invertebrate community. The EPT taxa metric as well contributes to taxonomic composition of the community (see graph in 'Ratio of disturbance sensitive to insensitive taxa').



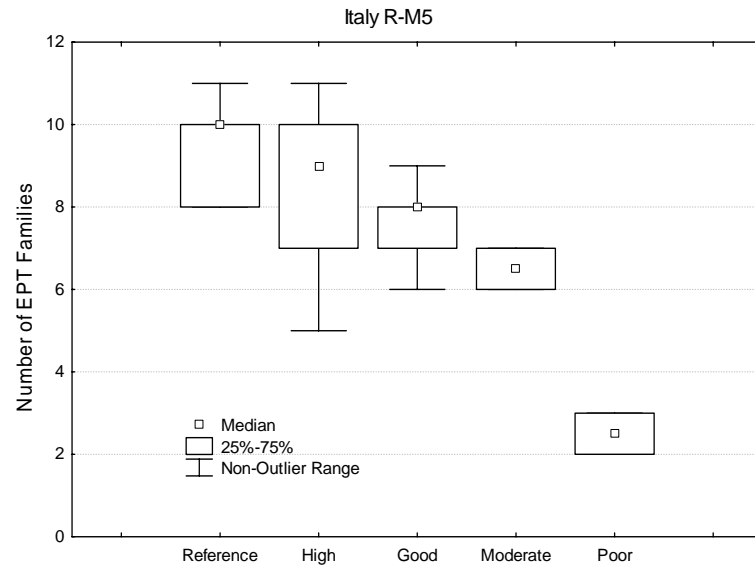
The abundance-based metric Sel EPTD_taxa accounts for invertebrate abundance (see above, right). The shift from REF to Good status in Sel EPTD_taxa is considered a slight change in the composition and abundance of the invertebrate community.

Abundance (in terms of abundance classes) is also used in Shannon-Wiener index calculation (see 'Level of diversity').

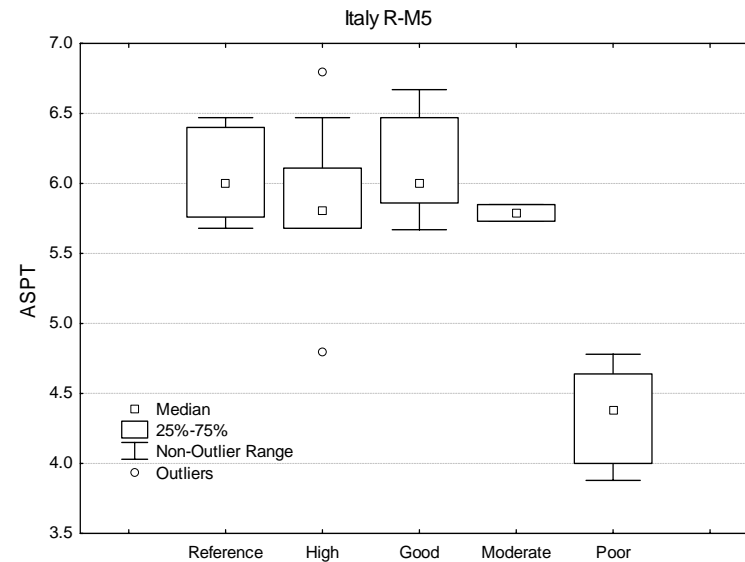
Ratio of disturbance sensitive to insensitive taxa (and missing major taxonomic groups)

EPT-Taxa can be seen as the most sensitive taxonomic groups in Med rivers. A positive value of this metric indicates that at least one of the three most sensitive major taxonomic groups is present in the community.

In the Italian R-M5 dataset, a minimum of 6 EPT Families was encountered at Good status, with 75% of samples bearing 7 or more EPT Families (below, left). The disappearance of EPT Families was never experienced. It appears than clearly how the most sensitive major taxonomic groups are always present in Good status samples according to the proposed boundaries.



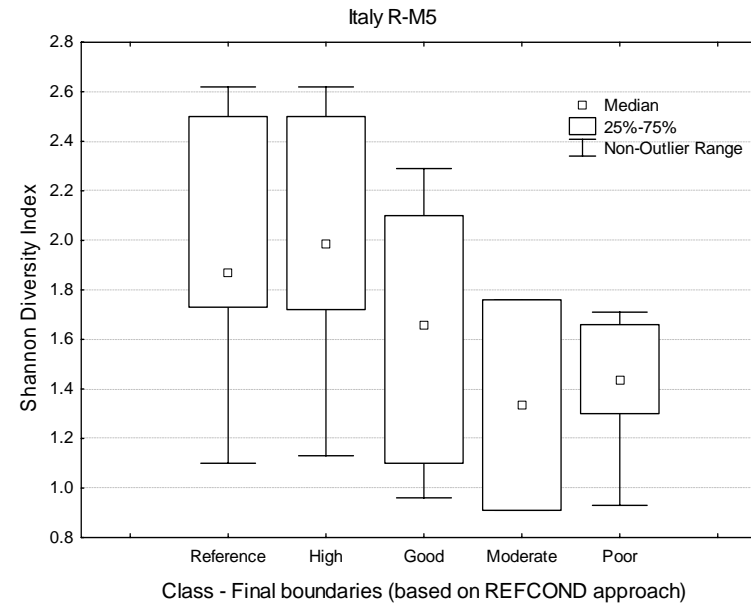
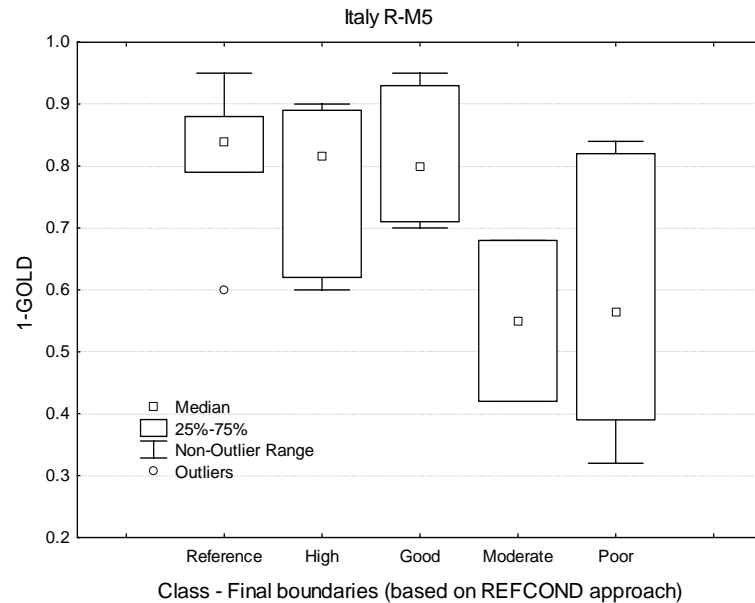
Class - Final boundaries (based on REFCOND approach)



Class - Final boundaries (based on REFCOND approach)

The ASPT metric is also shown, which should account for the Ratio of disturbance sensitive to insensitive taxa (figure above, right). For the Good status class, it shows values comparable to those observed at Reference sites (less than 0.2 unit of variation). This metric seems not to discriminate well in this stream type.

On the contrary, 1-GOLD (below, left) is somewhat informative in this stream type.



Level of diversity

The level of diversity of invertebrate taxa is here reported in terms of Shannon-Wiener diversity index (see graph below). The variation of this metric in Good status samples shows only slight signs of alteration from reference sites levels (Median of REF: 1.9; Median of Good status: 1.7, with a range going to values lower than 1).

Diversity, in terms of Richness of the community, is presented in 'Taxonomic composition and abundance' (Total Number of Families).

Overall trend of STAR_ICMi classes

The distribution of the values of the STAR_ICM index (which incorporates all the metrics shown above) in the 5 Ecological Status classes is shown to describe the general trend of values into quality classes and at REF sites.

