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R E P O R T

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REPORT ON FITTING THE ITALIAN NATIONAL METHOD FOR THE EVALUATION OF THE ECOLOGICAL QUALITY OF LAKE WATERBODIES USING BENTHIC DIATOMS (EPI-L) IN THE "PHYTOBENTHOS CROSS-GIG" INTERCALIBRATION EXERCISE

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1. Introduction

When the Cross-GIG phytobenthos intercalibration exercise was carried out, there was no specific Italian national method for the evaluation of the ecological quality of lake waterbodies using benthic diatoms. It was assumed that the common intercalibration metric could be used to replace the national method.

However, during the exercise itself it became evident that the common metrics was not strongly correlated to the trophic pressure in the Italian lakes. As a consequence, a new method was developed, namely EPI-L, on the basis of data collected by Environmental Agencies and Research Institutes in 80 lakes covering a long trophic gradient in both the Alpine and Mediterranean ecoregion.

This reports aims to evaluate to compare the value of the class boundaries of EPI-L with those agreed in the inter-GIG intercalibration exercise following the “Instruction manual to fit new or revised national classifications to the completed IC exercise”.

Lake quality classification should be carried out at the biological quality element (BQE) level. However, no intercalibration exercise was carried out for the “macrophyte and phytobenthos” BQE. For this reason, this report will only deal with the phytoplankton subelement.

2. Description of the method

The EPI-L method is used assess lake water quality on the basis of the composition of the benthic diatom assemblages and is calibrated against a single human pressure: eutrophication.

2.1. Dataset used

A total of 119 epilithic and periphytic diatoms samples were collected and analysed by seven Environment Agencies and two other Research Institutions in 80 lakes, following UNI (2005). When possible, submersed stones were sampled. Some samples were also collected on *Phragmites* stems or submersed macrophytes (*Najas marina*, *Chara rudis*). Some samples collected on artificial substrates were also considered for comparison purpose. The full data set include 475 taxa and 119 samples. A list of sampled lakes is reported by Marchetto et al. (2013). Twenty lakes were sampled more than once, and in nine lakes samples were collected and analysed by operator of different institutions, allowing an estimation of index repeatability (Marchetto et al., 2013).

2.2. Computation detail of the EPI-L index

The EPI-L index is based, as most composition indices, on the Zelinka & Marvan (1961) weighted averaging formula. Species occurring with an abundance higher than 1% in less than 3 lakes or never reaching a minimum abundance of 3% in any sample were discarded.

For the remaining 109 species, a trophic weight (p) was obtained by the average of the epilimnetic total phosphorus concentration, weighted by the abundance of that species in each lake (a). The indicator value (v) was obtained as the average of the squared differences between the trophic weight of the species and the epilimnetic total phosphorus concentration in each lake, weighted by the abundance of that species in each lake. Indicator values higher than 30 were replaced with 30.

EPI-L is the obtained on the basis of the following formula:

$$EPI-L = 4 - 2\frac{\sum_{i=1}^{n} a_i p_i v_i}{\sum_{i=1}^{n} a_i v_i}$$

The sum of abundance of the *n* species used for the calculation should account for at least 70% of the total abundance for that sample.

Trophic weights and indicator values are reported in table 1

Table 1 – Trophic values (p) and indicator values (v) for the EPI-L index

Code	Taxon	p	v
ACAF	Achnanthidium affine	1.01	28.4
ACLI	Achnanthidium lineare	0.79	30.0
ADHE	Achnanthidium helveticum	0.45	30.0
ADMI	Achnanthidium minutissimum	1.09	4.6
ADPY	Achnantidium pyrenaicum	1.24	12.6
ADSA	Achnanthidium saprophilum	1.27	9.9
ADSB	Achnanthidium straubianum	1.22	22.0
ADSU	Achnanthidium subatomus	1.14	30.0
AINA	Amphora inariensis	1.49	11.6
APED	Amphora pediculus	1.35	9.0
ANIV	Aulacoseira nivalis	0.80	30.0
AUGR	Aulacoseira granulata	1.48	20.4
BMIC	Brachysira microcephala	0.68	12.3
BVIT	Brachysira vitrea	0.69	30.0
CAEX	Cymbella excisa	1.34	8.4
CAFF	Cymbella affinis	1.51	6.4
CATO	Cyclotella atomus	1.48	10.4
CBAM	Cymbopleura amphicephala	1.42	11.3
CLEM	Cyclotella lemanensis	1.59	19.1
CCOS	Cyclotella costei	1.14	7.3
CCIS	Cymbella cistula	1.30	10.9
CCMS	Cyclotella comensis	0.67	30.0
CHEL	Cymbella helvetica	1.44	20.6
CKUT	Cyclotella kuetzinghiana	1.34	30.0
CMLF	Craticula molestiformis	0.50	30.0
COCE	Cyclotella ocellata	1.44	6.8
COPL	Cocconeis pseudolineata	1.31	24.9
CPLA	Cocconeis placentula	1.55	10.4
CPLI	Cocconeis placentula var lineata	1.28	30.0
HRAD	Handmannia radiosa	1.24	4.0
DDEL	Delicata delicatula	0.62	30.0
DMES	Diatoma mesodon	0.60	30.0
DSTE	Discotella stelligera	1.42	30.0
DSTO	Discotella stelligeroides	0.52	18.0
DTEN	Denticula tenuis	0.99	5.1
EADN	Epithemia adnata	1.31	30.0
ECAE	Encyonema caespitosum	1.68	17.8
ECES	Encyonema cesatii	0.58	17.1
ECPM	Encyonopsis minuta	0.84	11.6
EEXI	Eunotia exigua	0.69	26.3

Code	Taxon	p	v
EMIC	Eunotia microcephala	1.46	7.4
ENCM	Encyonopsis microcephala	0.78	10.1
ENLB	Encyonema langebertalotii	0.98	6.4
ENMI	Encyonema minutum	0.94	5.7
ENPA	Encyonmena paucistriatum	0.79	20.0
ENVE	Encyonema ventricosum	1.61	6.9
EOMI	Eolimna minima	1.36	12.0
ESLE	Encyonema silesiacum	0.92	5.6
ESOR	Epithemia sorex	1.35	30.0
ESUM	Encyonopsis subminuta	0.87	6.5
EUFL	Eucocconeis flexella	0.48	30.0
FCAP	Fragilaria capucina	1.21	8.5
FCRO	Fragilaria crotonensis	1.50	15.3
FCVA	Fragilaria capucina var. vaucheriae	1.36	14.6
FGRA	Fragilaria gracilis	1.27	3.3
FNAN	Fragilaria nanana	0.84	7.2
FPEM	Fragilaria perminuta	1.28	17.4
FRUM	Fragilaria rumpens	1.27	16.1
FTEN	Fragilaria tenera	0.85	8.7
GMIN	Gomphonema minutum	1.15	12.4
GOLI	Gomphonema olivaceum	1.32	30.0
GOLL	Gomphonema olivaceolacuum	1.28	30.0
GPAR	Gomphonema parvulum	1.42	5.0
GPUM	Gomphonema pumilum	1.56	10.2
GTER	Gomphonema tergestinum	1.27	30.0
GTRU	Gomphonema truncatum	1.21	9.2
KCLE	Karayevia clevei	1.35	30.0
MPMI	Mayamaea permitis	1.48	30.0
MSMI	Mastogloia smithii	1.54	19.1
MVAR	Melosira varians	0.80	6.2
NAMP	Nitzschia amphibia	1.52	8.7
NANT	Navicula antonii	1.28	14.7
NCPL	Nitzschia capitellata	1.44	10.0
NCPR	Navicula capitoradiata	1.39	6.0
NCTE	Navicula cryptotenella	1.26	7.7
NDIS	Nitzschia dissipata	1.47	8.2
NFON	Nitzschia fonticola	1.49	10.5
NIFR	Nitzschia frustulum	1.64	11.7
NILA	Nitzschia lacuum	1.71	8.7
NSTS	Nitzschia soralensis	1.46	18.9
NMEN	Navicula menisculus	1.39	23.7

Code	Taxon	p	v
NMIC	Nitzschia microcephala	1.52	18.1
NPAL	Nitzschia palea	1.32	7.1
NREC	Nitzschia recta	1.25	7.4
NSOC	Nitzschia sociabils	1.53	12.5
NTAB	Nitzschia tabellaria	1.32	11.1
NTEN	Navicula tenelloides	1.39	30.0
NTPT	Navicula tripunctata	1.68	15.2
NVEN	Navicula veneta	1.74	30.0
PLVU	Planothidium lacus-vulcani	0.66	7.5
PMNF	Pinnularia microstauron var nonfasciata	0.94	7.1
PMRG	Psammothidum marginulatum	0.60	30.0
PMTC	Psammothidium curtissimum	0.88	4.6
PRST	Planothidium rostratum	1.24	30.0
PSCT	Psammothidium scoticum	0.83	5.5
PTLA	Planothidium lanceolatum	1.41	16.5
RABB	Rhoicosphenia abbreviata	1.33	30.0
RGIB	Rhopalodia gibba	1.51	18.5
RSIN	Reimeria sinuata	1.15	14.4
SBRV	Staurosira brevistriata	1.24	6.6
SBND	Staurosira binodis	0.86	9.1
SCON	Staurosira construens	0.98	7.0
PSSE	Pseudotaurosira elliptica	0.81	2.5
SLIN	Surirella linearis	0.76	11.1
SSMU	Staurosira mutabilis	1.06	4.7
SSVE	Staurosira venter	1.23	7.6
TFLO	Tabellaria flocculosa	0.99	7.2
UUAC	Ulnaria ulna var acus	1.24	7.8
UULN	Ulnaria ulna	1.34	16.3

2.3. Relationship between EPI-L and the trophic pressure

An EPI-L value was obtained for 75 out of the 80 lakes used for the its calibration. In effect, in 5 lakes less than 70% of diatoms found in any sample was included in the species list reported in table 1. Figure 1 reports the relationship between EPI-L in the epilimnetic total phosphorus concentration (TP) for these 75 lakes. When more samples were available for a given lake, an average of the EPI-L values was used. In figure 1, lakes were split in shallow and deep (average depth lower or higher than 15 m, respectively) and in medium alkalinity (MA) or high alkalinity (HA) on the basis of the alkalinity value (lower or higher than 1 meq L^{-1}, respectively).

A part one outlier, an high altitude reservoir (Lake Morasco), the EPI-L index is strongly correlated to the trophic gradient (R^2=0,76).

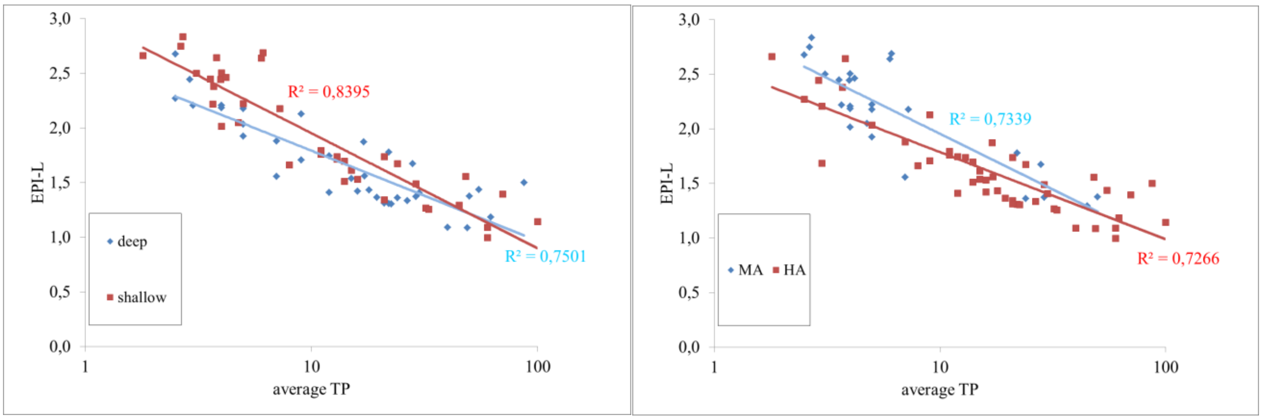

Fig. 1 – Relationship between epilimnetic phosphorus concentration and EPI-L.

TP expressed in µg L^{-1} (logarithmic scale)

The relationship between EPI-L and the trophic pressure has different slopes for deep and shallow lakes, so that the calibration of the model has been performed separately for this two lake types.

2.4. National reference conditions and boundary setting

National reference conditions were set on the basis of lakes having very low or negligible trophic pressure, because there was no habitants in their catchments or because all sewage in their catchment area were collected, and there was no intensive agriculture in the catchment. They are the following deep lakes: Fusine Inferiore, Tenno, Molveno and Mergozzo and the shallow lakes Fusine Superiore, Palù, Campo, Paione Inferiore, Paione Medio, Capezzone, Pojala, Matogno, Boden Inferiore e Boden Superiore, di Latte e di San Pancrazio.

Reference value was obtained as a median of the EPI-L values of the reference lakes and was 2.27 for deep lakes and 2.46 for shallow lakes.

Boundary setting was performed separately for deep and shallow lakes using the same statistical procedure: a regression tree (Breiman et al. 1984) was calculated using EPI-L as the only independent variable. The procedure produces lake clusters and the division in two main clusters represents the largest difference in species composition along the trophic gradient. This value was used to set the boundary between "good" and "moderate" status and was 1.37 for deep lakes and 1.52 for shallow lakes. All other class boundaries were selected in order to have equal class width in the Ecological Quality Ratio (Table 2).

Tab. 2 – Class boundaries. Values in bold represents EQR_{lim} (see below).

Boundary	Deep lakes		Shallow lakes	
	EPI-L	EQR	EPI-L	EQR
Reference	2.27		2.46	
High/Good	1.82	0.80	1.99	0.81
Good/Moderate	1.37	**0.60**	1.52	**0.62**
Moderate/Poor	0.92	0.41	1.05	0.43
Poor/Bad	0.47	0.24	0.58	0.24

The ecological quality ratio (EQR) is calculated on the basis of the reference value (rif) as EQR = EPI-L/rif. EQR values higher than one should be set to 1.

To combine EPI-L with the macrophyte index, both are transformed in "normalized EQR" (EQR_{norm}) and then they are averaged. To convert EQR in EQR_{norm}, the following formula is used:

$$EQR_{norm} = 1 - \frac{(1 - EQR) * 0,40}{1 - EQR_{\lim}}$$

Where EQR_{lim} is the EQR values of the good/moderate boundary.

3. FD compliance checking

Compliance checking should be performed at the level of the BQE, rather than just the "phytobenthos" sub-element. However, the intercalibration exercise was performed at the sub-element level, so in this report only the "phytobenthos" subelement will be considered.

Table 2 lists the criteria from the IC guidance and compliance checking conclusions.

Table 2 Compliance checking of phytobenthos methods

Compliance criteria	**Conclusions**
Ecological status is classified by one of five classes (high, good, moderate, poor and bad)	Yes. See § 2.4
High good and moderate ecological status are set in line with the WFD normative definition	Yes. See § 2.4
All relevant parameter of the BQE are covered and a combination rule too combine parameter assessment into BQE is defined.	Yes, but in this report only the "phytobenthos" parameter is covered, as an intercalibration exercise at the BQE level was never performed before.
Assessment is adapted to intercalibration common types that are defined in line with the topological requirements of the WFD Annex II.	The EPI-L calibration is performed on two national types (deep lakes and shallow lakes) which are in line with the requirements of the WFD, but EPI-L values can be calculated for both the IC common types.
The waterbody is assessed against type-specific near-natural reference conditions	Yes. See § 2.4
Assessment results are expressed in EQR	Yes
Sampling procedure allows for representative information about water body quality in space and time	Yes. Sampling procedure follow CEN standards and a good repeatability of the results is obtained also for single point sampling in a waterbody
All data relevant for assessing biological parameters specified in the WFD normative definition are covered by the sampling procedure	Yes, but in this report only the "phytobenthos" parameter is covered, as an intercalibration execise at the BQE level was never performed before
Selected taxonomic level achieves adequate confidence and precision in classification	Yes, taxonomic level request is the species level.

4. IC feasibility checking

4.1. Typology

In the cross-GIG exercise, GIG specific types were amalgamated to form very broad types. The EPI-L method is calibrated on national, narrower, types but is also appropriate for the common types.

4.2. Pressure addressed

In the cross-GIG intercalibration exercise, all national methods were calibrated to address a single human pressure: eutrophication. EPI-L is also calibrated against a trophic gradient.

In the intercalibration exercise, a confounding effect of acidity in low alkalinity lakes was detected. However, in Italy there are no significant lacustrine waterbodies with low alkalinity.

The relationship between EPI-L and the logarithm of the epilimnetic concentration of total phosphorus (TP) is significant for both IC lake types:

For high alkalinity lakes: $n = 48$, $R^2 = 0.73$, $p < 0.05$

For moderate alkalinity lakes: $n = 27$, $R^2 = 0.74$, $p < 0.05$

4.3. Assessment concept

All assessment methods included in the IC exercise focus on the littoral zone of the lake, sampling either stones or macrophyte stems and evaluate the proportions of different species in a fixed count.

EPI-L follows the same assessment concept.

5. Data set used

For the purpose of this exercise, a reduced dataset was developed with only one sample for lake, selecting samples where at least 70% of the counted diatoms valves belonging to the species lists of both EPI-L and the IC common metric (Rott’s TI).

When more than one sample per lake was available, the sample with the higher proportion of counted valves belonging the indices species lists was selected.

The final data set includes 39 high alkalinity lakes and 25 medium alkalinity lakes.

6. IC of the medium alkalinity lakes

The cross-GIG intercalibration was performed using IC option 2 and continuous benchmarking. As a consequence, it is necessary to adopt the procedure listed under 4.2 in the “Instruction manual to fit new or revised national classifications to the completed IC exercise”.

1. Calculate the value of the common metric (CM_obs) for sites in the national dataset.

The common metric (ICM) is an EQR derived from Rott’s Trophieindex (TI) using the following formula /(for high alkalinity lakes):

$$ICM = TIEQR = (4-TI) / (4- 1.88)$$

Results are listed in table 3.

2. Using the global relationship between the common metric and pressure established in the completed exercise, calculate the expected values of the common metric (CM_pred) for the joining method’s national dataset from its associated pressure data.

The global relationship between the ICM and the epilimnetic total phosphorus (TP, $\mu g\ L^{-1}$) is reported by Kelly et al. (submitted) as:

$$ICM = -0{,}243*\log_{10}(TP)+1{,}235$$

Results are listed in table 3.

3. Use OLS regression to define the relationship between CM_pred (y) and CM_obs (x). From this relationship create CM_bm by projecting CM_obs onto CM_pred. This will eliminate any systematic bias in CM_obs relative to CM_pred. An alternative is to calculate the mean residual between (CM_pred - CM_obs) and then create CM_bm = CM_obs + residual.

The mean residual between CM_{pred} and CM_{obs} is 0.116. CM_{bm} values are listed in table 3.

4. Use OLS regression to establish the relationship between CM_bm (y) and the joining national EQR (x).

The OLS regression between CMbm and the EQRs of the national metric is shown in figure 2. National EQRs where calculated for each lake by dividing the EPI-L value by the reference value, namely 2.27 for deep lakes and 2.46 for shallow lakes.

Table 3 – Lake-by-lake results of the intercalibration procedure. Deep lakes are marked with an asterisk.

Lake	altitude (m)	TP annual (µg L^{-1})	Rott's TI	CM_{obs}	CM_{pred}	$CM_{pred}-CM_{obs}$	CM_{bm}	EPI-L	national EQR
Antrona*	1083	5	1.19	1.07	1.07	-0.01	1.19	1.92	0.85
Cuga*	642	24	2.42	0.60	0.90	0.30	0.72	1.36	0.60
San Valentino alla Muta	1449	13	1.52	0.95	0.96	0.02	1.06	1.72	0.70
Liscia*	178	29	2.14	0.71	0.88	0.17	0.83	1.37	0.60
Maggiore*	194	7	2.12	0.72	1.03	0.31	0.83	1.56	0.69
Mergozzo *	194	4	1.14	1.09	1.09	0.00	1.21	2.30	1.02
Mezzola*	199	22	1.41	0.99	0.91	-0.08	1.10	1.91	0.84
Molveno*	823	4	1.14	1.09	1.09	0.00	1.21	2.18	0.96
Orta*	290	5	1.08	1.11	1.07	-0.05	1.23	2.18	0.96
Palù	1925	5	1.63	0.91	1.07	0.16	1.02	2.11	0.86
Pattada*	561	50	2.25	0.67	0.82	0.15	0.78	1.38	0.61
Posada	43	45	2.14	0.71	0.83	0.13	0.82	1.29	0.53
Sos Canales*	711	28	1.43	0.98	0.88	-0.10	1.10	1.67	0.74
Paione Inferiore	2002	3	0.78	1.23	1.13	-0.10	1.35	2.75	1.12
Capezzone	2100	4	1.32	1.02	1.10	0.08	1.14	2.22	0.90
Pojala	2305	5	2.25	0.67	1.07	0.40	0.79	2.18	0.88
Matogno	2067	4	1.26	1.05	1.09	0.04	1.16	2.01	0.82
Boden Inferiore	2334	4	1.82	0.83	1.09	0.26	0.95	2.44	0.99
Boden Superiore	2343	4	1.32	1.02	1.10	0.08	1.14	2.45	1.00
Panelatte	2063	7	2.88	0.43	1.03	0.60	0.54	1.09	0.44
Aplabersee	2367	3	1.27	1.04	1.12	0.07	1.16	2.50	1.02
suedlichter Kofferrastersee	2405	6	2.26	0.66	1.04	0.38	0.78	1.30	0.53
Milchsee	2540	3	1.00	1.15	1.13	-0.02	1.26	2.84	1.15
Timmelsschwarzsee *	2514	3	1.13	1.09	1.14	0.04	1.21	2.68	1.18
Kratzbergersee	2119	4	1.32	1.02	1.08	0.06	1.14	2.46	1.00

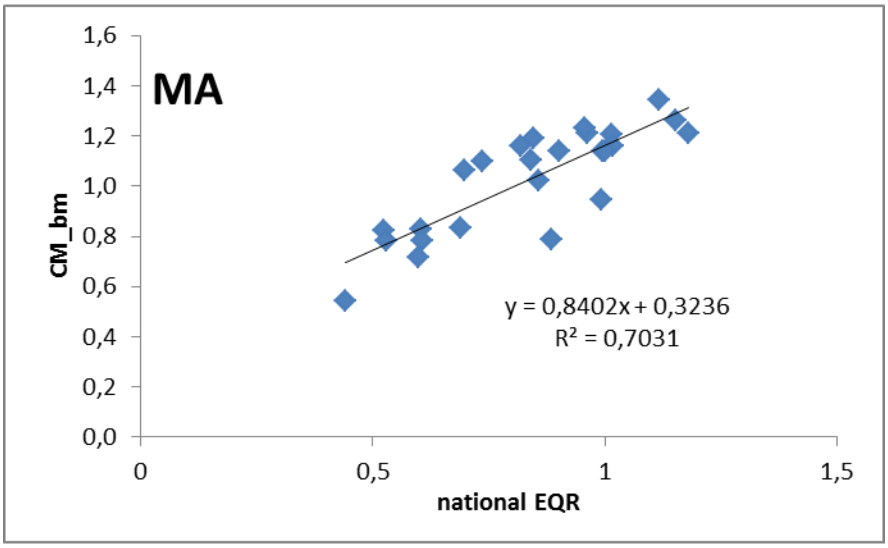

Fig. 2 - Relationship between the national EQR and the common metric benchmarked

5. *Predict the position of the national class boundaries (MP, GM, HG and ref) on the CM_bm scale.*

The predicted projections of the national boundaries on the CM_{bm} scale, together with the common view of the boundaries are reported in table 4.

Table 4 – Predicted projections of the national boundaries on the CM_{bm} scale and common view for medium alkalinity lakes

Boundary	Projection of the national EQRs on the IC common metric		Common view EQRs
	deep lakes	shallow lakes	
H/G	0.997	1.003	0.849
G/M	0.831	0.843	0.588
M/P	0.664	0.682	0.309
P/B	0.498	0.522	0.025

6. *Apply the comparability criteria as summarized in Chapter 5.*

Both the national H/G and G/M boundary falls **above the common view** by about 90% of one class width. The reason for this differences can be found in the different distribution of TP concentration in Italian lakes and in the intercalibration data set.

In the IC dataset, TP concentration ranges between around 3 and 1,000 µg L^{-1}, while in the Italy no significant lacustrine waterbody has TP concentration higher than 200 µg L^{-1}.

This difference in TP distribution may be related to both a difference in hydrological features (deeper lakes with shorter residence time), and/or to the fact that the protection of lake water quality from eutrophication was introduced in the Italian law in 1985 (Decree no. 667), resulting in strong reduction of lake trophy in the whole country (see for example Salmaso et al. 2007).

Apparently, the Italian dataset represents mainly the part of the trophic gradient corresponding to high and good quality in the cross-GIG common view. The main distinction within the Italian dataset was considered to distinguish good from moderate status, but it corresponds to the high-good boundary in the IC common view.

For this reason, the national boundaries should be reduced in order to approach the IC common view. The new, revised national boundaries are reported in table 5:

Table 5 – Revised national boundaries, predicted projections of the national boundaries on the CM_{bm} scale and common view for medium alkalinity lakes

Boundary	EPI-L		National EQR	Projection of the national EQR on the IC common metric	common view EQR in the common metric
	deep	shallow			
Reference	2.27	2.46			
H/G	1.70	1.85	0.750	0.954	0.849
G/M	1.14	1.23	0.500	0.744	0.588
M/P	0.57	0.62	0.250	0.534	0.309
P/B	0.11	0.12	0.050	0.366	0.025

7. IC of the high alkalinity lakes

The cross-GIG intercalibration was performed using IC option 2 and continuous benchmarking. As a consequence, it is necessary to adopt the procedure listed under 4.2 in the “Instruction manual to fit new or revised national classifications to the completed IC exercise”.

7.1. Procedure

1. Calculate the value of the common metric (CM_obs) for sites in the national dataset.

The common metric (ICM) is an EQR derived from Rott’s Trophieindex (TI) using the following formula /(for high alkalinity lakes):

$$ICM = TIEQR = (4-TI) / (4- 1.88)$$

Results are listed in table 6.

2. Using the global relationship between the common metric and pressure established in the completed exercise, calculate the expected values of the common metric (CM_pred) for the joining method’s national dataset from its associated pressure data.

The global relationship between the ICM and the epilimnetic total phosphorus (TP, $\mu g\ L^{-1}$) is reported in the intercalibration report (Kelly et al., draft) as:

$$ICM = -0{,}382*\log_{10}(TP)+1{,}431$$

Results are listed in table 6.

3. Use OLS regression to define the relationship between CM_pred (y) and CM_obs (x). From this relationship create CM_bm by projecting CM_obs onto CM_pred. This will eliminate any systematic bias in CM_obs relative to CM_pred. An alternative is to calculate the mean residual between (CM_pred - CM_obs) and then create CM_bm = CM_obs + residual.

The mean residual between CM_{pred} and CM_{obs} is -0.020. CM_{bm} values are listed in table 6.

4. Use OLS regression to establish the relationship between CM_bm (y) and the joining national EQR (x).

The OLS regression between CM_{bm} and the EQRs of the national metric is shown in figure 2. National EQRs where calculated for each lake by dividing the EPI-L value by the reference value, namely 2.27 for deep lakes and 2.46 for shallow lakes.

Table 6 – Lake-by-lake results of the intercalibration procedure. Deep lakes are marked with an asterisk.

Lake	altitude (m)	TP annual ($\mu g\ L^{-1}$)	Rott's TI	CM_{obs}	CM_{pred}	CM_{pred} -CM_{obs}	CM_{bm}	EPI-L	national EQR
Albano*	293	20	2.13	0.88	0.94	0.06	0.86	1.37	0.60
Alserio	280	8	1.91	0.99	1.09	0.10	0.97	1.66	0.68
Annone (western basin)	224	29	2.73	0.60	0.87	0.28	0.58	1.49	0.61
Grande di Avigliana*	352	70	1.22	1.31	0.73	-0.59	1.29	1.27	0.56
Bidighinzu	330	100	2.14	0.88	0.67	-0.21	0.86	1.14	0.46
Bolsena*	305	22	2.02	0.93	0.92	-0.01	0.91	1.32	0.58
Bracciano*	164	16	2.09	0.90	0.97	0.07	0.88	1.42	0.63
Caldonazzo*	450	7	2.09	0.90	1.11	0.21	0.88	1.88	0.83
Candia	227	16	1.71	1.08	0.97	-0.11	1.06	1.54	0.62
Cavazzo*	195	3	1.29	1.28	1.25	-0.02	1.26	2.29	1.01
Cavedine*	241	17	1.43	1.21	0.96	-0.25	1.19	1.87	0.82
Chiusi	251	32	2.77	0.58	0.86	0.27	0.56	1.27	0.51
Endine	334	15	2.09	0.90	0.98	0.08	0.88	1.61	0.66
Fusine Inferiore*	924	3	1.79	1.04	1.28	0.24	1.02	1.26	0.56
Fusine Superiore	929	4	0.99	1.42	1.21	-0.21	1.40	2.64	1.07
Garlate*	198	12	2.25	0.83	1.02	0.19	0.81	1.88	0.83
Grande di Monticchio	656	87	1.73	1.07	0.69	-0.38	1.05	1.50	0.61
Levico*	440	5	1.66	1.11	1.16	0.06	1.09	2.04	0.90
Lungo	371	48	1.57	1.15	0.79	-0.36	1.13	1.56	0.63
Martignano*	207	15	2.07	0.91	0.98	0.07	0.89	1.58	0.70
Massaciuccoli	2	21	2.43	0.74	0.93	0.18	0.72	1.74	0.71
Monterosi	237	55	1.52	1.17	0.77	-0.40	1.15	1.44	0.58
Morasco*	1815	3	1.64	1.11	1.25	0.13	1.09	1.69	0.74
Nemi*	318	27	2.41	0.75	0.89	0.14	0.73	1.33	0.59
Paterno*	617	40	2.87	0.53	0.82	0.29	0.51	1.09	0.48
Piccolo di Monticchio	658	23	2.22	0.84	0.91	0.07	0.82	1.30	0.57
Piediluco	368	45	2.05	0.92	0.80	-0.12	0.90	1.30	0.53
Pusiano	259	11	1.96	0.96	1.03	0.07	0.94	1.87	0.76
Ragogna	188	13	2.08	0.90	1.01	0.10	0.88	1.87	0.76
Ripasottile	371	60	2.34	0.78	0.75	-0.03	0.76	1.02	0.41
Scanno*	922	21	1.68	1.09	0.93	-0.17	1.07	1.44	0.63
Segrino	374	11	2.25	0.82	1.03	0.21	0.80	1.74	0.71
Sirio*	271	18	1.91	0.99	0.95	-0.03	0.97	1.47	0.65
Toblino	245	24	2.08	0.91	0.90	0.00	0.89	1.67	0.68
Piccolo di Avigliana	356	70	1.74	1.06	0.73	-0.34	1.04	1.37	0.56
Trasimeno	259	60	2.16	0.87	0.75	-0.11	0.85	1.04	0.42
Turano*	540	62	1.40	1.23	0.75	-0.48	1.21	1.28	0.56
Vico*	507	21	2.22	0.84	0.93	0.08	0.82	1.30	0.57
Viverone*	230	30	2.50	0.71	0.87	0.16	0.69	1.50	0.66

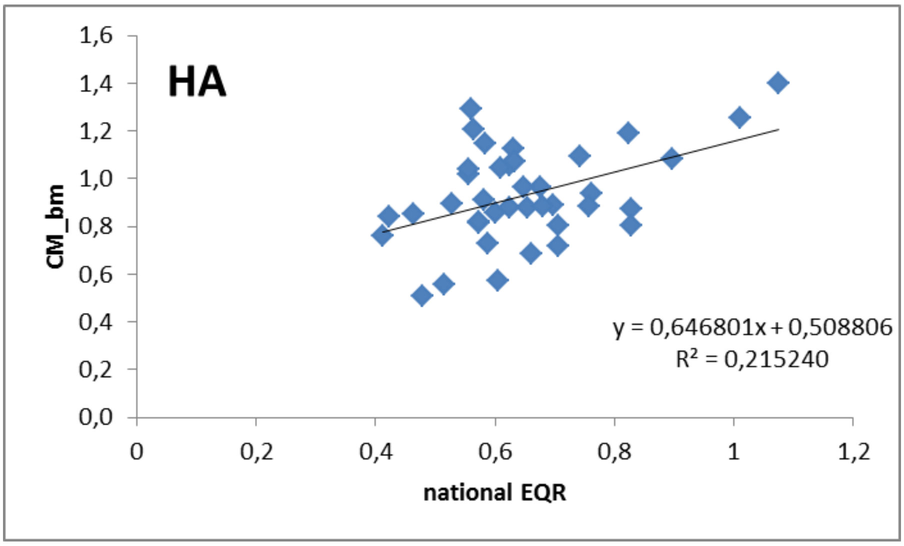

Fig. 3 – Relationship between the national EQR and the common metric benchmarked

5. *Predict the position of the national class boundaries (MP, GM, HG and ref) on the CM_bm scale.*

The predicted projections of the national boundaries on the CM_{bm} scale, together with the common view of the boundaries are reported in table 7.

Table 7 – Predicted projections of the national boundaries on the CM_{bm} scale and common view for high alkalinity lakes.

Boundary	Predicted projection		Common view
	deep lakes	shallow lakes	
H/G	1.031	1.699	0.965
G/M	0.901	1.404	0.790
M/P	0.771	1.109	0.604
P/B	0.641	0.814	0.416

6. *Apply the comparability criteria as summarized in Chapter 5.*

Both the national H/G and G/M boundary falls **above the common view** by about 60% class width for deep lakes and around 3 class widths for shallow lakes. The reason for this differences can be again found in the different distribution of TP concentration in Italian lakes and in the intercalibration data set, as discussed for medium alkalinity lakes.

For the same reason, the national boundaries should be reduced in order to reduce the difference with the IC common view. The new, revised national boundaries are reported in table 8:

Table 8 – Revised national boundaries, predicted projections of the national boundaries on the CM_{bm} scale and common view for medium alkalinity lakes

Boundary	EPI-L		National EQR	Projection of the national EQR on the IC common metric	common view EQR in the common metric
	deep	shallow			
Reference	2.27	2.46			
H/G	1.70	1.85	0.750	0.954	0.849
G/M	1.14	1.23	0.500	0.744	0.588
M/P	0.57	0.62	0.250	0.534	0.309
P/B	0.11	0.12	0.050	0.366	0.025

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