

First application of the epiphytic and epilithic diatoms index (EPI-L) for the evaluation of lake ecological quality in Italy: a case study from Umbria (central Italy)

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1. Introduction

In response to The European Directive 2000/60/EC, the Italian Ministry of Environment invited Regions to join a "Program on Lake Diatoms" to design a national method for the evaluation of lake ecological quality. Environmental Protection Agency of Umbria (A.R.P.A. Umbria) participated to the Program following the guidelines for sampling and analysing benthic diatoms in lakes provided by Institute for Ecosystem Studies of the National Research Council (ISE-CNR). A new index (EPI-L) was developed on the basis of data collected by Environmental Agencies and Research Institutes in 2012.

2. Study area and Methods

Table 1. Characteristics of two study lakes

	Area (km²)	Max Depth (m)	Mean Depth (m)	Perimeter (km)	Altitude m a.s.l.	Total Phosphorus Annual mean (mg/l)
L. Trasimeno	128.0	6	4.3	54	259	0.04
L. Piediluco	1.6	19	10.8	13	368	0.05



Fig.1a Map with sampling sites of Lake Trasimeno



Fig.1b Map with sampling sites of Lake Piediluco

LEGEND:
Urban areas
Industrial areas
Sampling sites

A.R.P.A. Umbria participated to the Program collecting and analysing diatoms from two sampling sites for each of the two main lakes in Umbria: Lakes Trasimeno and Piediluco (Tab.1; Fig.1a and Fig.1b). Sampling sites were representative of water bodies and human-impacted areas, had suitable substrates (pebbles or macrophytes) and were easy to access. Diatom identification followed Sußwasserflora von Mitteleuropa (Krammer et al. 2004-2007) and Diatoms of Europe (Lange-Bertalot 2001-2003).

4. Discussion and conclusion

The present work illustrates the challenges to be tackled for a correct application of EPI-L:

- several species recorded in the two lakes are not currently incorporated in the index, therefore the lakes' evaluation is incomplete;
- some lake's diatom taxa are poorly known and difficult to identify, therefore training courses on identification and ring-test exercises are needed;
- reference lakes in the Mediterranean ecoregion have not yet been identified, and this has to be done to enable biologically meaningful assessments of the ecological quality of Mediterranean lakes.

3. Results

We recorded 67 diatom species (Tab. 2). Dominant species were *Encyonema caespitosum*, *Fragilaria gracilis*, *Navicula cryptotenelloides* in L.Trasimeno, and *Cyclotella ocellata*, *Achnanthidium minutissimum*, *Amphora pediculus* in L. Piediluco.

Table 2. Diatom species recorded in two study lakes

Taxa	L. Trasimeno TRS1	L. Trasimeno TRS18	L. Piediluco PIE12	L. Piediluco PIE13
<i>Achnanthidium minutissimum</i> (Kützing) Czarnecki			5.8	28.1
<i>Achnanthidium eutrophilum</i> (Lange-Bertalot) Lange-Bertalot	4.5	4.0		
<i>Amphora inariensis</i> Krammer		0.5		
<i>Amphora copulata</i> (Kützing) Schoeman & Archibald			0.5	
<i>Amphora pediculus</i> (Kützing) Grunow	8.0	10.0	2.5	15.8
<i>Aneumastus apiculatus</i> (Oestrup) Lange-Bertalot	4.5	1.0		
<i>Caloneis lanceifolia</i> (Schulz-Danzig) Lange-Bertalot & Witkowski			0.5	
<i>Coccconeis neothumensis</i> Krammer	0.5	2.0		
<i>Coccconeis pediculus</i> Ehrenberg			0.5	
<i>Coccconeis placenta</i> Ehrenberg var. <i>euglypta</i> (Ehrenberg) Grunow			1.5	2.4
<i>Coccconeis placenta</i> Ehrenberg var. <i>lineata</i> (Ehr.) Van Heurck	0.5	0.5		
<i>Coccconeis placenta</i> var. <i>pseudolineata</i> Geitler			2.0	2.4
<i>Cyclotella ocellata</i> Pantocsek			69.8	26.2
<i>Cymbella affiniformis</i> Krammer			0.5	
<i>Cymbella cymbiformis</i> Agardh				0.7
<i>Cymbella excisiformis</i> Krammer var. <i>excisiformis</i>			0.3	
<i>Cymbella hustedtii</i> Krasske				2.4
<i>Cymbella parva</i> (Smith) Kirchner in Chon			0.5	
<i>Cymbella proxima</i> Reimer in Patrick & Reimer var. <i>proxima</i>			0.3	0.2
<i>Diploneis separanda</i> Lange-Bertalot		0.5		
<i>Eunotia bilunaris</i> (Ehr.) Mills var. <i>bilunaris</i>				0.5
<i>Encyonema caespitosum</i> Kützing	22.8	21.3	0.3	0.5
<i>Encyonema lacustre</i> (Agardh) F.W.Mills	0.3			
<i>Encyonema minutum</i> (Hils) D.G.Mann			0.8	
<i>Encyonema silesiacum</i> (Bleisch in Rabh.) D.G. Mann			0.5	
<i>Encyonema microcephala</i> (Grunow) Krammer		0.8		
<i>Eolidia minima</i> (Grunow) Lange-Bertalot			0.3	
<i>Epithemia adnata</i> (Kützing) Brébisson	0.3			
<i>Epithemia sorex</i> Kützing			0.5	
<i>Fragilaria capucina</i> var. <i>vaucheriae</i> (Kützing) Lange-Bertalot	2.5	4.0	0.3	
<i>Fragilaria construens</i> (Ehr.) Grunow			1.8	
<i>Fragilaria gracilis</i> Ostrup	11.0	15.5	1.8	1.2
<i>Fragilaria permixta</i> (Grunow) Lange-Bertalot	4.3	4.8		
<i>Fragilaria pinnata</i> Ehrenberg			0.2	
<i>Gomphonema acuminatum</i> Ehrenberg			0.7	
<i>Gomphonema olivaceum</i> (Hornemann) Brébisson var. <i>olivaceum</i>	0.8	2.0		
<i>Gomphonema parvulum</i> (Kützing) Kützing				1.9
<i>Gomphonema truncatum</i> Ehrenberg			0.8	0.7
<i>Gomphonema pumilum</i> (Gr.) Reichardt & Lange-Bertalot	1.5		0.5	4.0
<i>Hantzschia amphioxys</i> (Ehrenberg) Grunow			0.3	
<i>Hippodonta capitata</i> (Ehr.) Lange-Bertalot & Witkowski			0.3	
<i>Hippodonta hungarica</i> (Grunow) Lange-Bertalot	0.3	0.3		
<i>Mastogloia smithii</i> Thwaites	8.0	1.3		
<i>Navicula capitaradiata</i> Germain	0.3	0.5		
<i>Navicula cryptotenella</i> Lange-Bertalot	2.0	2.5	2.0	1.7
<i>Navicula cryptotenelloides</i> Lange-Bertalot	13.5	4.3	0.3	
<i>Navicula jakovlevicii</i> Hustedt			0.5	
<i>Navicula joubaudii</i> Germain			0.5	
<i>Navicula tripunctata</i> (Müller) Bory			1.0	1.2
<i>Navicula veneta</i> Kützing			0.3	
<i>Nitzschia amphibia</i> Grunow			0.8	0.5
<i>Nitzschia fonticola</i> Grunow			1.3	4.0
<i>Nitzschia filiformis</i> (W. M. Smith) Van Heurck	0.5	0.5		
<i>Nitzschia palea</i> (Kützing) W. Smith			0.3	
<i>Nitzschia inconspicua</i> Grunow	1.3	4.5		
<i>Placoneis pseudanglica</i> (Lange-Bertalot) Cox			0.2	
<i>Pseudostaurosira breviseta</i> (Grunow) Williams & Round			0.8	
<i>Reimeria uniseriata</i> Sala Guerrero & Ferrario			0.3	
<i>Rhoicosphenia abbreviata</i> (Ag.) Lange-Bertalot	0.5			0.2
<i>Rhopodium gibba</i> (Ehr.) O. Müller var. <i>gibba</i>	6.3	7.0		
<i>Seminavis strigosa</i> (Husted) Danieleidis & Economou-Amilli	1.5	0.8		
<i>Staurosira elliptica</i> (Schumann) Williams & Round	3.0	6.0		
<i>Staurosira grigorskyi</i> Morales & Ector	1.0	1.0		
<i>Staurosira punctiferum</i> Witkowski, Metzeltin & Lange-Bertalot	0.5	1.8		
<i>Tabularia fasciculata</i> (Agardh) Williams et Round	0.3	0.8		
<i>Ulnaria ulna</i> (Nitzsch.) Compère			1.5	0.5
<i>Ulnaria ulna</i> (Nitzsch.) Compère var. <i>acuta</i> (Kütz.) Lange-Bertalot			2.3	1.7
Total	100	100	100	100

We evaluated lake ecological quality

quality (Tab.3) using revised national

boundaries after

"Phytobenthos

Cross-GIG"

Intercalibration

Exercise

(Marchetto,

2014).

Table 3. Results of application of EPI-L index and percentages of the counted valves belonging to the EPI-L species list (% sp. abundance)

EPI-L	L.Trasimeno		L.Piediluco	
	TRS1	TRS18	PIE12	PIE13
EQR	0.392	0.423	0.494	0.527
EQR Mean	0.408		0.511	
Classification	Moderate		Good	
% sp. abundance	70.4	82.8	96.5	90.5

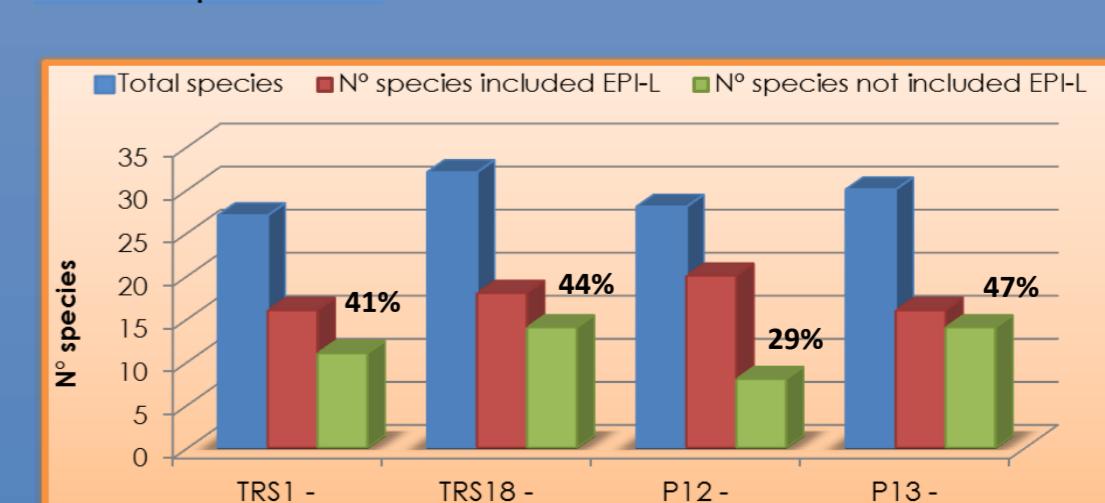


Figure 2. Number of species not included in the EPI-L and their percentages of the total species

Number of species not included in the index is in Figure 2.