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MACROPHYTE RICHNESS AND AQUATIC VEGETATION COMPLEXITY OF THE LAKE IDRO (NORTHERN ITALY)

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Abstract – A detailed survey was performed to examine the floristic richness, structural complexity, spatial patterns and conservation value of the submerged aquatic vegetation (SAV) in the littoral zone of the Lake Idro (Northern Italy). During the summers 2010 and 2011 the SAV was analyzed with standardized procedures, exploring both transects (44) and plots (49). Lake Idro is characterized by rather high floristic richness (20 macrophyte species) but low levels of the structural complexity of vegetation communities (8 units). A clear zonation of the littoral vegetation was identified with two main macro-layers: a deep layer (between 6-10 m depth) dominated by *Chara globularis* and a surface layer (from 0 to 6 m depth) mainly colonized by alien elodeids, with the dominance of *Elodea nuttallii* and *Lagarosiphon major*. The first complete floristic-vegetation analysis of the Lake Idro evidences the poor ecological status of the littoral zone, even though all the vegetation communities described are of conservation concern. Ongoing investigations will further highlight relationships between eutrophication and macrophyte communities.

Keywords: Submerged aquatic vegetation (SAV), Species diversity, Plant communities complexity, Depth gradient, Habitat Directive

Introduction

In lakes and shallow standing waters, hydro-hygrophilous vegetation plays a central role in modulating nutrient cycles and controlling trophic status of waters (Wetzel, 1990; Scheffer & Carpenter, 2003; Bolpagni et al., 2007; Pierobon et al., 2010). In these ecosystems, the food webs are influenced by species richness and structural complexity of the submerged aquatic vegetation (SAV) (Verhoven et al., 2006, Scheffer & Jeppesen, 2007). Lacustrine submerged plant assemblages are extremely sensitive to human impacts and other disturbance processes: littoral habitat alteration or destruction, pollution, negative water balance, and alien species invasions (Jeppesen et al., 2011). Over the last century, in most developed countries lakes were characterized by a steep decline of macrophytes which often resulted in the complete disappearance of the SAV with dramatic consequences for freshwater fauna (Hicks & Frost, 2011). In order to counteract the decline in macrophytes and the aquatic habitats loss, several actions have been issued since the Convention on Wetlands (Ramsar, 1971; Beijen, 2009). In the European Water Framework Directive (2000/60/EC) macrophytes are assumed as key biological elements for assessing the ecological quality of water bodies (Penning et al., 2008; Søndergaard et al., 2010). Hence, in Europe intensive monitoring programs were promoted to fill the knowledge gap concerning SAV and to develop indicators and indices for evaluating the conservation status of macrophyte communities (see Oggioni & Bolpagni, 2010; Oggioni et al., 2011). In Italy, despite the great number of lakes of interest, only few studies were carried out to assess the conservation status of SAV and related littoral habitats (Azzella et al., 2013. Currently, regular data are available exclusively for the Lake Garda (Giardino et al., 2007; Bresciani et al., 2012; and the volcanic lakes of Central and Southern Italy (Azzella et al., 2011, 2013; Azzella, 2012).

This paper reports the main outcomes of a two years study of the SAV in the eutrophic and meromictic Lake Idro as a part of a wider project intended to evaluate the ecological status of the lake (Nizzoli et al., 2012; Bolpagni, 2013). The main

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aims are to analyze (*a*) floristic richness and structural complexity, (*b*) spatial patterns of SAV species along the depth gradient in the euphotic zone of the lake, and (*c*) conservation values of macrophytic communities in accordance with the EC Habitat Directive. In addition, the results of this study can fill in the knowledge gap on aquatic flora and vegetation in deep Alpine lakes. They also allow update the preliminary information gathered by Galanti (unpublished data), Roberti (2004) and Bolpagni & Tomaselli (2005).

Materials and methods

Study area

Lake Idro is one of the deep Alpine lakes with a surface of ~ 11 km^2, a maximum depth of 124 m and a volume of 8.5 10^8 m^3. It is located at an altitude of 368 m a.s.l. at the border of the provinces of Brescia and Trento, between Lombardy and Trentino-Alto Adige Regions (Fig. 1). It is a meromictic lake with a trophic status that ranges from mesotrophic to eutrophic. The upper mixed layer is 40 m deep at most. Concurrently, the deeper water layer accounts for ~ 50% of the total water column, which is anoxic (Nizzoli et al., 2012). Lake Idro is man-regulated since 1930s and underwent a sudden and quick eutrophication which likely control biogenic meromixis starting from 1960s (Garibaldi et al., 1996). Relationships between water abstraction and water level fluctuations were not analyzed, whilst we can argue that fluctuations seriously stressed the littoral vegetations. Lake Idro represents an important economic resource at the local level it being used for tourism and various recreational activities beyond water sports and fishing (Bresciani et al., 2011).

Macrophytes characterization

The macrophyte community was studied between July 2010 and August 2011 with the phytosociological approach (Braun-Blanquet, 1964) and with 49 releveés. Data were processed with a hierarchical Cluster Analysis based on group-average linking of Bray-Curtis similarities that was performed in R environment (version 2.15, http://www.r-project.org/). The syntaxonomical scheme of

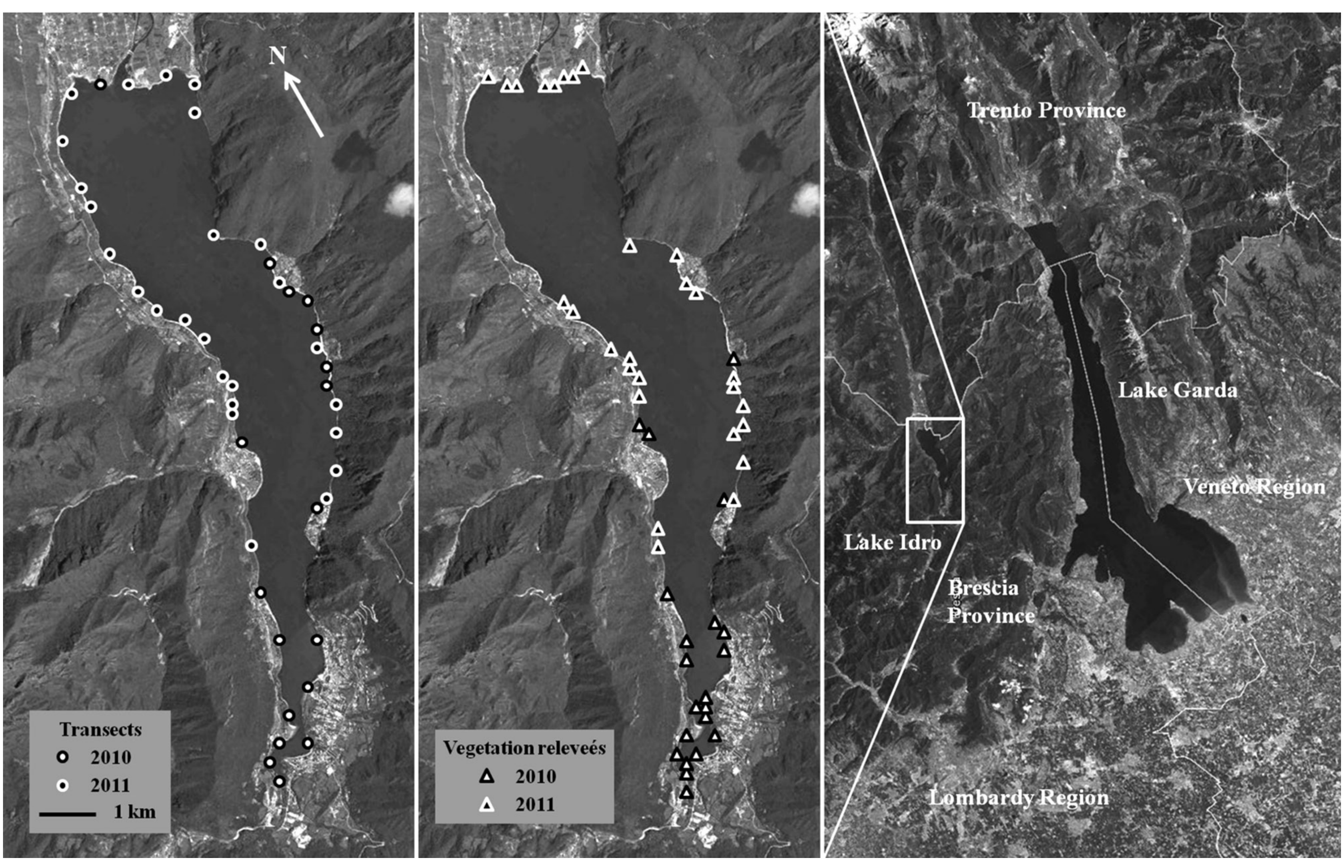

Fig. 1. - Maps of the study area, showing the location of transects and vegetation releveés.

the vegetation units was mainly derived from Grabherr & Mucina (1993) and Bardat et al. (2004). The spatial analysis of plant communities was performed along 44 transects, identified on the basis of information from unpublished data of Galanti and Roberti (2004), and in accordance with the criteria provided by Oggioni et al. (2011). Briefly, a preliminary survey was performed in order to split the lake shore into homogeneous littoral stretches, mainly in terms of helophytic and macrophyte vegetation structure. Subsequently, one floristic and vegetation transect was selected within each homogeneous stretch collecting data from each 1-meter depth interval up to the maximum colonization depth. For each species detected both presence (frequency) and percentage cover-abundance were recorded. For each unit of vegetation, the CORINE Biotopes code, the correspondent Habitat code (in agreement with the Annex I of the EU Habitat Directive), and a brief analysis of their conservation value were provided.
Vascular species nomenclature follows Conti et al. (2005, 2007), with the exception of the alien *taxa* that are reported in accordance with Celesti-Grapow et al. (2009); for bryophytes and algal species, nomenclature follows Cortini Pedrotti (2001) and John et al. (2002), respectively.

Results

Analysis of the floristic richness and structural complexity of macrophyte communities

Overall, 20 macrophyte species, including 15 phanerogams (*Lagarosiphon major*, *Myriophyllum spicatum*, *Elodea nuttallii* are the most widespread and abundant species), four algal *taxa* (*Chara globularis*, *C. vulgaris*, *Cladophora aegagrophyla*, and *Spirogyra* sp.) and one bryophyte (*Fontinalis antipyretica*) and eight vegetation types were found. The proposed syntaxonomical scheme is reported in Tab. 1; an overview of the floristic dissimilarities among the aquatic vegetation types (belonging to the *Charetea* and *Potametea* classes) is presented in Tab. 2.

Macroalgal vegetation (*Charetea* class). The releveés dominated by charophytes were referred to the class *Charetea*, grouping macro-algae vegetations of standing and flowing inland surface or transitional waters. In this study only one community belonging to this class was recorded. Below 5-6 m depth, dense stands of *C. globularis* (***Cf***) became

Table 1. Syntaxonomical scheme. CC = community code; IL = interest level (European = E or regional = R); HC = EU Habitat code or CORINE Biotopes code.

Class	Order	Alliance	Community type	CC	IL	HC
Charetea fragilis Fukarek ex Krausch 1964	*Charetalia hispidae* Sauer ex Krausch 1964	*Charion fragilis* Krausch 1964	*Charetum fragilis* Fijalkowski 1960	***Cf***	E	3140
Potametea Klika in Klika & Novák 1941	*Potametalia* W.Koch 1926		*Myriophyllum spicatum* community	***Ms***	E	3150
		Potamion pectinati (W.Koch 1926) Libbert 1931	*Potamogeton lucens* community	***Pl***	E	3150
			Potamogeton perfoliatus community	***Pp***	E	3150
			Potamogeton pusillus community	***Pu***	R	*22.422*
			Elodea nuttallii community	***En***	R	*22.422*
			Lagarosiphon major community	***Lm***	R	*22.422*
Littorelletea Braun-Blanq. & Tüxen ex V.Westh., Dijk & Passchier 1946	*Littorelletalia* W.Koch 1926	*Eleocharition acicularis* Pietsch 1967	*Eleocharis acicularis* community	***Ea***	E	3130

Table 2. Synoptic table of the aquatic vegetation, classes *Charetea (A),* and *Potametea (B*); for plant community abbreviations see Tab. 1. *No. of plots* = number of releveés, *SP mean* = average number of species *per* plot; *SP max* = maximum number of species *per* plot; *SP min* = minimum number of species *per* plot.

	(A)	*(B)*					
Community type	***Cf***	***Ms***	***Pl***	***Pp***	***Pu***	***En***	***Lm***
No. of plots	*17*	*4*	*2*	*3*	*4*	*9*	*5*
SP mean	*1.9*	*4.0*	*3.0*	*3.3*	*4.0*	*3.2*	*2.8*
SP max	*4*	*5*	*4*	*4*	*5*	*5*	*5*
SP min	*1*	*2*	*2*	*2*	*3*	*2*	*2*
Charetea							
Chara globularis	V	III	.	.	II	I	.
Potametea							
Myriophyllum spicatum	I	V	III	II	V	V	III
Potamogeton lucens	.	IV	V	.	.	.	.
Potamogeton perfoliatus	I	II	III	V	.	.	I
Potamogeton pusillus	.	.	.	II	V	III	.
Elodea nuttallii	III	IV	.	V	IV	V	II
Lagarosiphon major	I	IV	V	IV	V	IV	V
Potamogeton crispus	.	I	.	.	.	I	.
Ranunculus trichophyllus trichophyllus	.	.	.	.	.	I	I
Elodea canadensis	.	.	.	.	.	I	.
Persicaria amphibia	.	.	.	.	.	.	I
Potamogeton pectinatus	.	.	.	I	.	.	.
Zannichellia palustris polycarpa	.	.	.	.	I	.	.
Companions							
Ceratophyllum demersum	.	I	.	.	I	.	.
Cladophora aegagrophila	I	.	.	.	.	.	.
Fontinalis antipyretica	.	.	.	.	.	.	I
Lemna minor	.	.	I	.	.	.	.
Myosotis palustris complex	.	.	.		.	I	.

dominant (Tab. 2). The depth limit of this species was ~ 10 m that also represented the growth limit of the macrophyte belt. *C. globularis* was the only constant species in this community, while vascular *taxa* were rare with rather low cover-abundance values (e.g., *E. nuttallii*, *L. major*, and *M. spicatum*). From 6 to 9 m depth, the macro-algae *Cladophora aegagrophila* frequently formed dense mats in association with filamentous algae of the genus *Spirogyra*.

Rhizophytic vegetation (*Potametea* class). In the depth range 2-6 m, the littoral zone was almost completely colonized by submerged rhizophytes, mainly represented by elodeis. In other words, by aquatic plants with well-developed root-rhizome systems that grew within the superficial sediments and fulfilled the functions of anchorage and nutrient uptake. These communities are referred to *Potametalia* potentially including three alliances (Bardat et al., 2004). However, only *Potamion pectinati* was found in the Lake Idro. This alliance includes the aquatic plant communities dominated by species of the *Potamogeton* genus and submerged rooted plants (e.g., *M. spicatum*, elodeids). These communities exhibited a reduced structural complexity with a single dominant species and few companions. Consequently, the numerical classification of releveés of *Potamion pectinati* allowed identifying six different plant communities that correspond to the number of the dominant species: *M. spicatum*, *Potamogeton lucens*, *P. perfoliatus*, *P. pusillus*, *E. nuttallii*, and *L. major*, respectively. All *taxa* exhibited a weak diagnostic power; consequently their communities cannot be assigned to a specific association but referred exclusively to a basal-phytocoenon. In general, rhizophyte communities were compositionally similar except for the dominant species.

The *M. spicatum* community (***Ms***) had a low species richness and the number of companion species did not exceed five (Tab. 2). Among the most frequent species there were *E. nuttallii*, *L. major* and *P. perfoliatus*, all characteristic of order and class. The *M. spicatum* community occurred in the middle and northern parts of the basin, where *M. spicatum* formed scattered stands between 2-6 m depth. In the southern sector of the basin, the elodeid facies were extremely heterogeneous. In particular, three communities dominated by species of the genus *Potamogeton* (*P. lucens, P. perfoliatus*, and *P. pusillus*) were found. Many stands of *P. lucens* (***Pl***) and *P. perfoliatus* (***Pp***) had a compositional structure very similar to *M. spicatum* community, although thus differ in terms of colonization depths (3-5 m compared to 1-3 m, respectively) (Tab. 2). The *P. pusillus* stands (***Pu***) were mainly restricted to the central-north portion of the lake, in presence of very coarse sediments with low silt and organic matter content. Usually, these communities were restricted to ~ 1-2 m depths. The most recurrent companion species was *E. nuttallii*. The other two rhizophytic communities were dominated by extremely aggressive alien *taxa*: *E. nuttallii* (***En***) and *L. major* (***Lm***), from Nord America and Southern Africa, respectively (Tab. 2). These two communities were the most widespread elodeid formations in the study area. Among the companion species, only *M. spicatum* and *Potamogeton* species contributed with relevant abundances. These two alien species formed almost monophytic submerged stands. Locally, *E. nuttallii* appeared to be more resistant to light extinction than *L. major*. As a consequence it can be found as the only companion species of *C. globularis*. The community of *L. major* was characterized by very high densities of *L. major* that reached cover-abundance values almost close to 100% (Tab. 2). Similarly to *E. nuttallii*, *L. major* was mainly found in the 2-6 m depth range of, with a very variable number of companion species with low cover-abundance values.

Amphibian vegetation (*Littorelletea* class). The perennial vegetations characterized by the dominance of small amphibious plants belong to the *Littorelletea* class. These communities were typical of shallow waters, with 1-2 m depth, and seasonally flooded areas (e.g., lake shores, intermittent wetlands). In the study area, we found stands dominated by *Eleocharis acicularis* (***Ea***) (Tab. 3) forming scattered submerged perennial communities belonging to the *Eleocharition acicularis* alliance (Tabs. 1, 3). *E. acicularis* is a very small species well-adapted to water-submersion but also with an intrinsic capability to change growth form to survive in waterlogged exposed sediments. Very few companion species were detected; only *E. acicularis* reached cover-abundances > 1.

Table 3. *Littorelletalia* class; *Eleocharis acicularis* community (*Ea*).

Transect	E1	9’’’	8	8	7
Depth interval	**1-2**	**2-3**	**2-3**	**1-2**	**2-3**
Relevé area (sq m)	**0.5**	**0.25**	**0.25**	**0.5**	**0.25**
Plant cover (%)	**80**	**85**	**90**	**65**	**70**
N. of species	*3*	*3*	*2*	*3*	*3*
***Eleocharis acicularis* community**					
Eleocharis acicularis	4	4	5	3	3
Companions					
Carex gracilis	+	.	.	r	+
Gratiola officinalis	.	.	.	+	.
Ranunculus trichophyllus subsp. *trichophyllus*	.	r	.	.	+
Carex elata subsp. elata	.	+	.	.	.
Salix alba (pl.)	.	.	r	.	.

Analysis of spatial patterns of macrophyte communities

On the whole, 7.2 ± 2.5 species (mean ± standard deviation) (Tab. 4), and an average species richness *per* transect of 5.7 ± 1.6 species (data not shown) were detected. In addition, a

Table 4. Detection frequencies (F = mean frequency, SD = Standard deviation) of the most widespread macrophytes of the Lake Idro. DI = Depth intervals; SD DI = species diversity at DI scale; Cha_glo = *Chara globularis*; Elo_nut = *Elodea nuttallii*; Fon_ant = *Fontinalis antipyretica*; Pot_pus = *Potamogeton pusillus*; Zan_pal = *Zannichellia palustris* subsp. *polycarpa*; Cha_vul = *Chara vulgaris*; Lag_maj = *Lagarosiphon major*; Myr_spi = *Myriophyllum spicatum*; Pot_per = *Potamogeton perfoliatus*; Pot_luc = *Potamogeton lucens*; Ran_tri = *Ranunculus trichophyllus* subsp. *trichophyllus*; Cer_dem = *Ceratophyllum demersum*; Cla_aeg = *Cladophora aegagrophila*; Spi = *Spirogyra* sp.

DI	*Cha_glo*	*Elo_nut*	*Fon_ant*	*Pot_pus*	*Zan_pla*	*Cha_vul*	*Lag_maj*	*Myr_spi*	*Pot_per*	*Pot_luc*	*Ran_tri*	*Car_dem*	*Cla_aeg*	*Spi*	SD DI
0-1	.	17.4	.	45.7	2.2	28.3	45.7	28.3	.	.	2.2	2.2	.	.	**8**
1-2	.	50.0	2.2	37.0	4.3	21.7	84.8	73.9	2.2	.	.	.	.	.	**8**
2-3	2.2	58.7	2.2	17.4	4.3	13.0	73.9	84.8	4.3	.	.	.	.	4.3	**10**
3-4	15.2	60.9	.	8.7	.	.	76.1	80.4	8.7	2.2	.	.	2.2	4.3	**9**
4-5	28.3	71.7	.	2.2	.	.	71.7	65.2	6.5	.	.	2.2	13.0	10.9	**9**
5-6	41.3	69.6	.	.	.	.	47.8	45.7	2.2	.	.	2.2	26.1	21.7	**8**
6-7	65.2	43.5	.	.	.	.	23.9	30.4	.	.	.	.	32.6	19.6	**6**
7-8	78.3	32.6	.	.	.	.	19.6	19.6	.	.	.	.	41.3	23.9	**6**
8-9	52.2	13.0	2.2	.	.	.	8.7	10.9	.	.	.	.	19.6	6.5	**7**
9-10	2.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.
F	*28.5*	*41.7*	*0.7*	*11.1*	*1.1*	*6.3*	*45.2*	*43.9*	*2.4*	*0.2*	*0.2*	*0.7*	*13.5*	*9.1*	**7.2**
SD	*29.3*	*25.0*	*1.1*	*17.0*	*1.8*	*10.8*	*30.8*	*30.6*	*3.2*	*0.7*	*0.7*	*1.1*	*15.6*	*9.4*	**2.5**

progressive reduction in species richness with the increase of depth was observed.
The spatial analysis of the macrophytic communities revealed a clear zonation of the littoral vegetation in the Lake Idro. Three different layers were found: 1) a superficial layer (0-1 m depth); 2) an intermediate layer (1-6 m depth); and 3) a deeper layer below 6 m (Tab. 4). The first layer was very sparsely colonized by plants including *P. pusillus*, *C. vulgaris*, *L. major*, and *M. spicatum* with low cover-abundance values. The intermediate layer hosted the highest level of plant richness and well-structured stands, with 10 species and cover-abundances between 75% and 100%. In this zone the most widespread species were *E. nuttallii*, *L. major*, and *M. spicatum.* On the contrary, the lower layer was almost exclusively composed by *C. globularis*, an algal species that usually forms dense stands from 5-6 m to the maximum growing depths. In this study, *C. globularis* did not grow at depths greater than 10 m that represent the maximum growing depth in the Lake Idro.

Discussion

Floristic richness and vegetation structure

Lake Idro is characterized by rather high floristic richness, but low levels of vegetation structural complexity. These outputs are in agreement with the results from previous floristic and vegetation surveys (Roberti, 2004; Bolpagni & Tomaselli, 2005). Overall, 20 macrophyte species and eight species-poor vegetation types were identified. The current status of the SAV likely depends on the scarce water quality, the lake waters being mesoeutrophic (Nizzoli et al., 2012). Previous studies also demonstrated that the recent evolution of the Lake Idro was strongly influenced by the nutrient enrichment especially from 1960s-1980s (Garibaldi et al., 1996). This is probably the main cause of the local low vegetation complexity and the reduced maximum depth of macrophyte colonization that does not exceed 10 m depth. Since 1930s to early 2000s the water levels underwent wide fluctuations up to 7 m, which deeply altered the littoral zone and the wetland surrounding the lake shore. Since 2007, after water level fluctuations were restricted to < 1.5 m, the littoral area was likely colonized by few alien opportunistic species which hampered the development of species-rich vegetation.
The spatial pattern of macrophyte communities reflects the results of the syntaxonomical analysis. In general, the littoral zone of Lake Idro colonized by aquatic plants (between 0 and 10 m of depth) can be split into two main macro-layers: a deeper layer (6-10 m depth) dominated by *C. globularis* and an upper layer (0-6 m depth) mainly colonized by elodeids (mainly *E. nuttallii* and *L. major*). The upper layer could be divided into a superficial (0-1 m of depth) and an intermediate layer (1-6 m of depth). The latter is characterized by *P. pusillus* and *Zannichellia palustris* subsp. *polycarpa*; the former is dominated by the two elodeis (*E. nuttallii* and *L. major*) and *M. spicatum*. This vertical distribution of macrophyte communities differs from that observed in other deep lakes (Pall & Moser, 2009. In the Lake Idro the intermediate charophyte belt, typically dominated by large sized species of *Chara* like *C. intermedia* and *C. tomentosa* between 2 and 6 m depth, was likely replaced by a dense and continuous meadow of large-sized elodeids (*E. nuttallii* and *L. major*).

Analysis of the macrophyte communities of conservation concern

All the vegetation types described above can be referred to habitats of conservation concern according to the Habitat Directive and Mariotti & Margiocco (2002). Specifically, the *Chara*-beds can be referred to the EU Habitat 3140, the *M. spicatum*, *P. lucens* and *P. perfoliatus* communities to the EU Habitat 3150, and the *E. acicularis* communities to the EU Habitat 3130. On the contrary, the *P. pusillus*, *E. nuttallii* and *L. major* communities (attributed to the CORINE Biotopes code 22.422) can be considered vegetation types of regional interest (Tab. 1).

EU Habitat 3130

Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea* (***Ea***). This habitat includes standing waters ranging from oligotrophic to mesotrophic conditions that host amphibious shoreweed communities (*Littorelletea*) and seasonally-exposed wetland areas hosting annual dwarf rush communities (*Isoëto-Nanojuncetea*). Their characteristic plant assemblage generally consists of ephemerophytes and small plants (mostly < 10 cm). In general, it is possible to refer a broad range of aquatic environments to this habitat type: from oligotrophic, muddy, ephemeral marginal wetlands and pond shores to mesotrophic deep lakes.

EU Habitat 3140

Oligomesotrophic waters with benthic vegetation of **Chara** formations (***Cf***). This habitat includes the oligotrophic to mesotrophic calcareous waters that host well-developed submerged communities of stoneworts (*Charetalia* order). These vegetation types have low species richness and depend on water chemistry and nutrient content (especially on P availability). In Northern Italy, these communities are scarcely investigated and only few empirical data are available to clarify the phytosociological position of *Chara*-dominated communities and their conservation value.

EU Habitat 3150

Natural eutrophic lakes with *Magnopotamion*- or *Hydrocharition*- type vegetation (***Ms***, ***Pl***, and ***Pp***). This habitat includes both natural eutrophic lakes and ponds. Under natural conditions all shallow waters, including their shores with floating and submerged aquatic vegetation (*Hydrocharition* and *Magnopotamion* alliances) belong to this habitat type [e.g., Duckweed communities (*Lemnetea*), Water-soldier (*Stratiotes aloides*) or Bladderworts (*Utricularia* ssp.)]. Almost all aquatic plant communities have been referred to this habitat type (e.g., *Lemnetea* and *Potametea*) (Biondi et al., 2009). However, several authors do not agree with this option and highlight how the equivalence between the EU Habitat 3150 definition and the corresponding syntaxonomic categories has not been completely investigated and clarified. For these reasons, the aquatic plant communities ambiguously referred to the EU Habitat 3150 (i.e., *Parvopotamnion* and *Nymphaeion*) have been also included in integrative habitat lists to provide them an adequate level of protection at local scale due to their high conservation concern (Mariotti & Marciocco, 2002; Bolpagni et al., 2010).

CORINE Biotopes 22.422

Small pondweed communities of the *Parvopotamion* alliance that colonize shallow and more sheltered waters (***Pu***, ***En***, and ***Lm***). Many authors (e.g., Biondi et al., 2009) suggest a correspondence between the *Parvopotamion* communities and the EU Habitat 3150. However, the correspondence between this habitat type and its syntaxonomic position is unclear (Biondi et al., 2009). In the absence of specific insights about the phytosociological position of vegetations belonging to the *Parvopotamion*, a syntaxonomic category that is currently considered invalid, we prefer to consider the vegetations dominated by elodeids separately to those of EU Habitat 3150.

Conclusions

This study documented the presence of simplified submerged vegetation. The reduced water transparency, likewise the wide fluctuations of water levels, followed by water level increase and stabilization selected plant communities dominated by opportunistic alien species. Despite these considerations, all the vegetation types are of conservation concern according to the EU Directive Habitat and the "Habitat Supplementary List" of Lombardy (Mariotti & Margiocco, 2002). Specifically, with respect to the elodeid communities, it is possible to consider a plant community dominated by alien species as a habitat of conservation concern when it allows preserving important ecosystem functions or representing a *refugium* for numerous endangered species. Indeed, in the Lake Idro the diffuse presence of aquatic meadows dominated by exotic elodeids contributes to control nutrients availability and to provide a suitable habitat for many fish species (e.g., pike, common bleak, tench, and perch). Similarly, the communities of *Paspalum distichum*, a tropical graminoid (Celesti-Grapow et al., 2009), are considered of conservation concern and referred to the EU Habitat 3280 (Biondi et al., 2009).

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