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The role of Potential Natural Vegetation for Natura 2000 Habitat monitoring

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Abstract
In the present paper, some criteria for evaluating the intrinsic and local relevance of Annex I Habitats (Dir. 92/43/EEC) are discussed with reference to the concept of Potential Natural Vegetation and Vegetation Series. We pointed out some phytosociological aspects suitable to be used for assessing the intrinsic value of Habitats and their real importance contextualized in the actual, current biodiversity of a given territory. We introduced the concept of Potential Natural Vegetation as a robust tool to evaluate the representativity and the gaps of the conservation framework and its suitability in safeguarding the actual and potential biodiversity of a territory. On the ground of a case study in Central Italy, we evaluated the effectiveness of Natura 2000 Network in its current configuration at regional scale, profiting from the informations included in the concept of Vegetation Series. The regional scale appeared to be suitable for a realistic evaluation of where, when and what should be done for Habitat management and conservation.

Key words: 92/43/EEC Directive, gap analysis, Italy, land use, management, phytosociology, PNV, Umbria, Vegetation Series.

Introduction

Since more than 30 years, it has been ascertained that the conservation of biological diversity requires the designation of areas where long-term persistence of species and ecosystems is secured (United Nations, 1992). In 1992 the European Economic Community (EEC) enacted the 92/43/EEC Directive (European Commission, 1992) on the conservation of natural habitats and of wild fauna and flora (known as ‘Habitats’ Directive). Its main objective was ‘to promote the maintenance of biodiversity’. The Habitats Directive includes a list of Habitat[1] types (Annex I) worthy of protection at the European level inside specifically designated Sites, composing Natura 2000 Network. A support for their recognition has been provided by the European Interpretation Manual (European Commission, 2013). In Italy, a National Interpretation Manual has been developed, offering a helpful tool for Habitat identification and pointing out robust connections between Annex I cathegories and phytosociological syntaxa (Biondi *et al*., 2009, 2012a; Biondi, 2013).

Habitats can be considered important indicators of biodiversity (Bunce *et al*., 2008, 2012) and a community approach may represent biodiversity more effectively than individual species (Noss, 1996; Cowling *et al*., 2004; Rodríguez *et al*., 2012). The establishment of Natura 2000, the world’s largest network of protected areas, can be considered one of the major EU results, although the proposed 2010 biodiversity targets have not been met. The 2020 Biodiversity strategy formulates six targets, among which Target 1 strives "to halt the deterioration in the status of all species and habitats covered by EU nature legislation and achieve a significant and measurable improvement in their status" (European Commission, 2011). It is evident that habitats represent a bench mark in the European nature conservation policy (Evans, 2006; Bunce *et al*., 2012; Biondi *et al*., 2012b; Biondi, 2013). In this frame, urgent aims to pursue are: i) consolidating the Natura 2000 Framework, ii) developing and putting into practice suitable management plans, iii) improving knowledge of ecosystems and their services.

An assessment of the actual effectiveness of protected areas for biodiversity conservation is an increasingly pressing issue (Iojă *et al*., 2010; Rubio-Salcedo *et al*., 2013). The suitability of Natura 2000 Network, with special reference to the adopted principles of Site designation, has been doubted or at least questioned at European, national and regional scale (Dimitrakopoulos *et al*., 2004; Araujo *et al*., 2007; Apostolopoulou & Pantis, 2009; Evans, 2010, 2012; Pullin *et al*., 2009; Gigante *et al*., 2011a; Gruber *et al*., 2012). Furthermore, in the last decade researchers focused on the development of a wide-scale accepted and globally applicable system for quantifying the level of threat for habitats and ecosystems and prioritizing the conservation efforts (Kontula & Raunio, 2009; Nicholson *et al*., 2009; Galdenzi *et al*., 2012; Rodríguez *et al*., 2012; Schmeller *et al*., 2012; Berg *et al*., 2014).

In this frame, main aim of the present study is to discuss traits, models and indicators suitable to be used for assessing the intrinsic value of Habitats and their real importance contextualized in the actual biodiversity of a given territory. We tried to evaluate the suitability of Natura 2000 Network in its current con-

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[1] We use the capital initial letter for "Habitat" to indicate Annex I Habitats.

figuration at regional scale, profiting from the informations included in the concepts of Vegetation Series (VS) and Potential Natural Vegetation (PNV) (Tüxen, 1956; Blasi *et al*., 2000, 2004; Rivas-Martínez, 2005; Bohn & Gollub, 2006; Mücher *et al*., 2009; Farris *et al*., 2010; Biondi *et al*., 2011). According to the interpretation proposed by Biondi (2011), who suggested to rename it as "current potential vegetation", the latter concept can be defined as "the type of vegetation that represents the most advanced stage in the serial succession within a given biogeographic area". Starting from this point, some questions could be addressed: which VS includes a higher presence of Annex I Habitats? Which are neglected and why? In which ways the knowledge about the VSs can offer tools for Habitat management? How to take care in a proper way of the large areas lacking in natural vegetation, which - as a matter of fact - have been ignored by Natura 2000? And more: do all the Annex I Habitats have the same conservation priority and need the same type of monitoring? If not, which criteria might be followed to create a priority list? Which aspects count more at the regional scale? The possibility to discriminate among Habitats' intrinsic priorities stands as an urgent need. With the present paper, we tried to enlighten on some of the mentioned open issues.

Materials and methods

Study area

The study area is represented by Umbria Region, one of the 20 Italian administrative Regions and a very heterogeneous territory widely representative of Central Italy. With a total surface of about 8,456 km^2, it is one of the smallest Italian Regions, but still rich in different environments, due to a large lithological diversification including 209 distinct lithological types (Jacobacci *et al*., 1970; Passeri, 1994; Regione Umbria, 2012), a wide altitudinal range of about 2,400 m, a rich spectrum of bioclimatic conditions including 2 Biogeographic Regions and 6 Bioclimatic Belts (Venanzoni *et al*., 1998; Pesaresi *et al*., 2014) and a long-dated human settlement, mainly centered along the major valleys.

Starting in 1995, the development of Natura 2000 in Umbria led to the formal identification of 104 Sites (97 SCI and 7 SPA). Thanks to a process coordinated at regional level, Annex I Habitats and related vegetation types have been studied and mapped in each Site at a detailed scale (1:10.000), providing a precious tool for management and conservation (Regione Umbria 2007, 2010). Many of the related phytosociological data are stored in the vegetational databank VegItaly (Venanzoni *et al*., 2012; Gigante *et al*., 2012; Landucci *et al*., 2012; Lucarini *et al*., 2014). At the same time, the potential diversity of the whole Region became rather well known thanks to the map of the Vegetation Series (Biondi *et al*., 2010a, 2010b) and the most recent phytosociological and geobotanical updatings (Gigante & Venanzoni, 2007a, 2007b; Angelini *et al*, 2012; Biondi *et al*., 2013; Gigante *et al*., 2011b, 2013a, 2013b). The detailed level of knowledge inside Natura 2000 Sites offered then a chance to test the real representativeness of this system for biodiversity conservation, compared to the natural potential diversity of the regional territory.

The data set developed for Natura 2000 Network in Umbria includes 104 Sites (97 SCI: about 1,217 km^2 and 7 SPA: about 472 km^2, partially overlapped), covering a total area corresponding to about 16% of the regional territory (Regione Umbria, 2007; M.A.T.T.M., 2013). On the ground of the most recent updatings, 40 Annex I Habitats (10 with priority importance) have been detected in Umbria (Venanzoni *et al*., 2006; Gigante *et al*. 2007a, 2007b, 2013c; Biondi *et al*. 2009, 2012a; Catorci *et al*., 2010; Frattegiani *et al*. 2010; Gigante & Venanzoni, 2010; Landucci *et al*., 2011, 2013; Genovesi *et al*., 2014). They represent about one third (31.3%) of the total number of Habitats in Italy, which according to Biondi *et al*. (2009, 2012a) amounts to 131. It's a remarkable amount, considering that the territory of Umbria Region has no coasts and is therefore missing all the littoral Habitats. On the ground of the recently produced Habitat maps (Regione Umbria, 2007, 2010), almost 70,000 ha are covered by Annex I Habitats, more than half of the whole Regional Network. Their complete list is reported in Table 1, including only the Habitat codes; for more details see Biondi *et al*. (2009, 2012a).

In combination with this large data set, the map of the Vegetation Series (VS hereafter) of Umbria Region was used (Biondi *et al*., 2010a, 2010b). The VS is a geobotanic unit which includes the complex of plant communities developing as successional stages inside an ecologically homogeneous land unit (Biondi, 1996, 2011; Blasi *et al*., 2000, 2004; Biondi *et al*., 2002; Rivas-Martínez, 2005). The VS map is strictly correlated to the concept of Potential Natural Vegetation (PNV hereafter): as proposed by Biondi (2013), we can state that each VS is the actual, current expression of the PNV of a homogeneous territory, including both mature and successional stages (Rivas-Martínez, 2005, Farris *et al*., 2010; Biondi, 2011). The VS map of Umbria Region includes 22 VSs and 4 Geoseries (G hereafter), listed in Table 2; for more details see Biondi *et al*. (2010a, 2010b).

Data analysis and methodology

In order to point out the intrinsic value of each detected Habitat in the regional context, we started from the

Tab. 1 - List of Annex I Habitats in Umbria and number of Sites where they have been detected (data source: Regione Umbria, 2007; M.A.T.T.M., 2013).

ID	3130	3140	3150	3170*	3240	3260	3270	3280	3290	4030	4060	4090	5110	5130	5230*	5330	6110*	6170	6210 (*)	6220*
N° of SCI	2	7	12	3	3	19	14	1	1	15	2	1	11	41	2	1	4	1	54	25

ID	6230*	6420	6430	6510	7210*	7220*	7230	8130	8210	8310	91E0*	91F0	91L0	91M0	91AA*	9210*	9260	92A0	9340	9540
N° of SCI	1	10	22	2	1	3	1	7	19	7	7	1	20	19	6	29	12	53	43	11

VS map of Umbria (Biondi *et al*., 2010a, 2010b) and crossed it with the current distribution of Natura 2000 Sites in the Region and the related Habitat maps. In this way, we could: 1) detect the presence of under-represented areas and 2) check and quantify the presence of each Habitat with reference to the potential territory of each VS and G. Our approach represents a more detailed application of the "gap analysis" methodology (Rodrigues *et al*., 2004; Gruber *et al*., 2012), adopted at a national scale in Italy by Rosati *et al*. (2007, 2008). In our study we could process the available data at a finer scale, by analyzing not only the perimeters of Natura 2000 Sites but also the distribution of each single Annex I Habitat. It was possible to evaluate number and surface of single Habitats inside each territory related to different PNV types.

With the aim to identify neglected elements that need further protection (gaps), we analyzed how many VSs (whose territory corresponds to a specific PNV) are actually involved in Natura 2000 Network and how much of their potential territory is included in Natura 2000 Sites. If a VS appeared to be not represented in the Network, we defined it as a "gap VS" (see Rodrigues *et al*., 2004; Gruber *et al*., 2012).

Starting from GIS maps, referred to a common coordinate system, it was possible to carry out a topological overlay involving all the available informative layers: VS map, Natura 2000 Sites map, Habitats map. In this way, we could calculate: a) rates of each VS included in Natura 2000 Sites, b) Habitat number and

Tab. 2 - Vegetation Series (VS) and Geoseries (G) in Umbria, corresponding to as much PNV types, grouped according to the Bioclimatic belt (Bb): for each VS the biogeographic and ecologic features composing the diagnostic sentences are reported, together with their phytosociologic reference; for each G the syntaxonomical ranks are reported in square brackets. For details, see Biondi *et al*. (2010a, 2010b).

Cryorotemperate Bb
1. Primary vegetation G (C-Apenninic, neutro-basiphilic) [*Leontopodio-Elynenion*, Arabidion *coeruleae*, *Thlaspienion stylosi*, *Ranunculo-Nardion*, *Salicion herbaceae*, *Seslerion apenninae*, *Saxifragion australis*]
Orotemperate Bb
2. G of the montane carstic plains (C-Apenninic, edapho-hygrophilic) [*Potamion*, *Nymphaeion albae*, *Phragmition*, *Magnocaricion*, *Glycerio-Sparganion*, *Caricion davallianae*, *Salicion cinereae*]
3. *Daphno oleoidis-Juniperion nanae* VS (CS-Apenninic, neutro-basiphilic)
Supratemperate Bb
4. *Cardamino kitaibelii-Fago sylvaticae* VS (C-Apenninic, neutro-basiphilic)
5. *Dactylorhizo fuchsii-Fago sylvaticae* VS (Umb/Mar, subacidophilic)
6. *Lathyro veneti-Fago sylvaticae* VS (C-Apenninic, neutro-basiphilic)
7. *Carici sylvaticae-Querco cerridis* VS (Umb/Mar, acidophilic)
Mesotemperate Bb
8. *Aceri obtusati-Querco cerridis* VS (Umb/Mar, neutro-basiphilic)
9. *Aceri obtusati-Querco cerridis pyro pyrastri* VS (Umb/Mar, subacidophilic)
10. *Scutellario columnae-Ostryo carpinifoliae* VS (C-Apenninic, neutro-basiphilic)
11. *Cephalanthero longifoliae-Querco cerridis* VS (Pre-Apenninic C-Thyrrhenian, acidophilic)
12. *Scutellario columnae-Ostryo carpinifoliae cytiso sessilifolii* VS (C-Apenninic, neutro-basiphilic)
13. *Coronillo emeri-Querco cerridis* VS (Pre-Apenninic C-Thyrrhenian, subacidophilic)
14. *Hieracio racemosi-Querco petraeae* VS (Tos/Umb, acidophilic planitial)
15. *Fraxino-Ulmenion minoris* VS (C-Italic, edapho-hygrophilic)
Meso-Submediterranean Bb
16. *Lonicero xylostei-Querco cerridis* VS (CN-Pre-Apenninic, neutro-basiphilic)
17. *Asparago tenuifolii-Querco cerridis* VS (Pre-Apenninic Umb/Lat, neutro-basiphilic)
18. *Erico arboreae-Querco cerridis* VS (Pre-Apenninic N-Thyrrhenian, acidophilic)
19. *Malo florentinae-Querco frainetto* (Pre-Apenninic C-Thyrrhenian, acidophilic)
20. *Asparago acutifolii-Ostryo carpinifoliae* VS (Pre-Apenninic C- Adriatic, neutrobasiphilic)
21. *Roso sempervirentis-Querco virgilianae* VS (Pre-Apenninic, neutrobasiphilic)
22. *Roso sempervirentis-Querco virgilianae erico multiflorae* VS (Pre-Apenninic Umb, neutrobasiphilic)
Mesomediterranean Bb
23. *Cyclamino hederifolii-Querco ilicis* VS (Peninsular-Italic, neutrobasiphilic)
24. *Cyclamino repandi-Querco ilicis* VS (Thyrrhenian, neutrobasiphilic/acidophilic)
Azonal Vegetation
25. G of the riparian vegetation (Peninsular-Italic, hygrophilic) [*Salicion albae*, *Populion albae*, *Alno-Ulmion*]
26. G of the freshwater vegetation (Peninsular-Italic, hydrophilic) [*Charetea fragilis*, *Lemnetea minoris*, *Nymphaeion*, *Potamion pectinati*, *Magnocaricion elatae*, *Phragmition australis*, *Alnion glutinosae*]

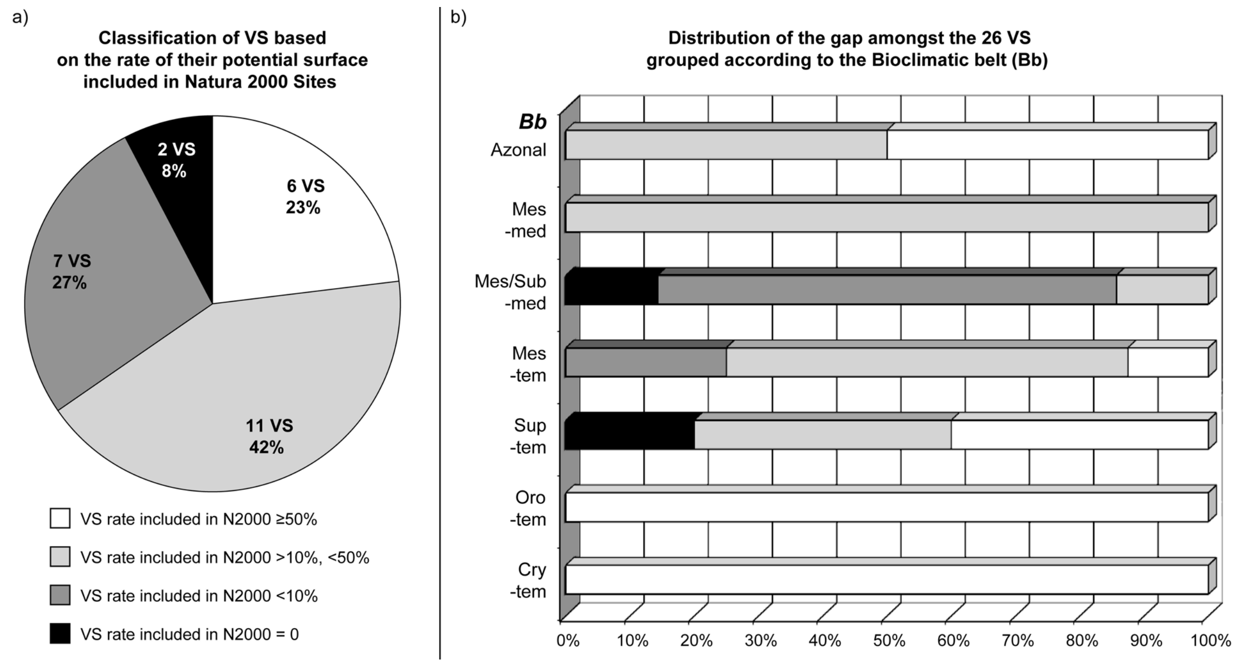

Fig. 1 - Rate of potential territory of each VS included in Natura 2000 Network. 1a: the rates of inclusion for each VS are referred to 4 protection levels, whose thresholds have been fixed at 0%, 10%, 50% and 100%. 1b: the VSs have been grouped according to the Bioclimatic belts (Bb): Cryorotemperate (Cry-tem), Orotemperate (Oro-tem), Supratemperate (Sup-tem), Mesotemperate (Mes-tem), Meso-Submediterranean (Mes/Sub-med), Mesomediterranean (Mes-med) plus the Azonal VSs. The black color indicates the gap VSs.

surface for each VS, c) Habitat rate of presence for each VS, the latter used as a measure of each Habitat's "exclusivity" to each VS.

In a second step, the analysis has been performed after a clustering of all the VSs on the ground of their bioclimatic characterization (Biondi *et al.*, 2010a, 2010b). We considered the 6 Bioclimatic belts detected in the Region, based on the application of bioclimatic parameters and indexes (Rivas-Martínez *et al.*, 1999; Rivas-Martínez, 2008; Pesaresi *et al.*, 2014): they are the Cryorotemperate, Orotemperate, Supratemperate, Mesotemperate, Meso-Submediterranean, Mesomediterranean Bioclimatic belts.

As suggested by Rosati *et al.* (2007, 2008), we fixed at 10% the lower limit for an acceptable rate of inclusion, below which the territory of each VS should be considered "under-protected". This threshold is one of the most frequently selected as a proper conservation target (Margules & Pressey, 2000; Myers *et al.*, 2000; Maiorano *et al.*, 2006). The upper limit of the class "protected" was fixed at 50%, while VSs included in Natura 2000 Network for more than 50% of their surface were considered as "widely protected". Of course, in case a VS appeared totally not represented in the Network, it was classified as "not protected" (gap VS).

All the cartographic analyses have been processed by using the Open Source Geographic Information System Quantum GIS (QGIS 2.0.1), licensed under the GNU General Public License (GPL) v.2, Free Documentation Licencse v.1.3 (QGIS Project, 2014).

The significativity of the detected differences among the VS groups has been tested by applying non-parametric Kruskal-Wallis Test. The relation between number of Annex I Habitats and rate of PNV occupied by Habitats, for each VS (averaged per Bioclimatic Belt) has been investigated by applying an analisys of independent samples based on non-parametric Kolmogorov-Smirnov Test. All the statistical analyses have been performed by using the software Analyst Soft Stat Plus: mac v2009.

Results

The overlay of the VS map of Umbria with the current distribution of Natura 2000 Sites in the Region pointed out a very heterogeneous representativeness of the VSs in the Network and the presence of many gaps (Figures 1a, 1b). Two VSs resulted in the cathegory “not-protected” and appeared to be completely neglected by Natura 2000: they were not included in any Site and could be defined as gap VS. They are the "Lower Supratemperate subacidophilous beech Series of Umbria-Marche Region" *Dactylorhizo fuchsii-Fago sylvaticae* sigmetum, and the "Lower Meso-Submediterranean, Pre-Apenninic, neutrobasiphilous, edafoxerophilous white oak series of Umbria Region" *Roso sempervirentis-Querco virgilianae erico multiflorae* sigmetosum (Table 2). In spite of the total absence of

Natura 2000 Sites in their territory, their successional stages include in many cases important Annex I Habitats, such as: H4030, H6210(*) and the prioritarian H9210* in the first case; H4030, H9540 and the prioritarian H91AA* in the latter.

Seven VSs appeared to be "under-protected", that means that their included area resulted to be less than 10% of their total PNV surface. Among them, we should cite the "Lower Meso-Submediterranean, Pre-Apenninic N-Thyrrhenian, acidophilous, Turkey oak series" *Erico arboreae-Querco cerridis* sigmetum, including H4030, H5130, H91M0 and the prioritarian H6220*; the "Lower Meso-Submediterranean, Pre-Apenninic, C-Thyrrhenian, acidophilous, Hungarian oak series" *Malo florentinae-Querco frainetto* sigmetum including H91M0 represented by the very rare Hungarian oak forests, close to their Western biogeographic limit. It should be remarked that the whole potential territory of both the Geoseries of primary vegetation (Cryorotemperate, C-Apenninic, neutro-basiphilic) and the *Daphno oleoidis-Juniperion nanae* VS (Orotemperate, CS-Apenninic, neutro-basiphilic) were completely included (100%) in Natura 2000 Sites.

When we consider the VSs grouped according to their Bioclimatic belts, we can see that the gap resulted more prominent for the Meso-Submediterranean VSs, followed by Supratemperate and the Mesotemperate ones (Figure 1b).

For each VS, we took into account number and surface of the mapped Habitats, confronting data both among VSs and among VS groups on a bioclimatic base (Figures 2, 3). The VSs of the lower Bioclimatic belts show very low rates of inclusion while the highest values of Habitat inclusion refer to the higher

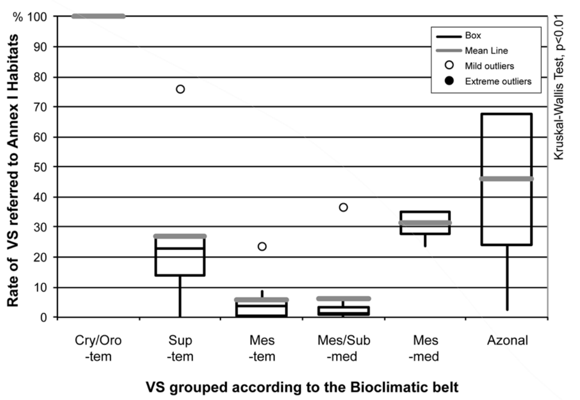

Fig. 2 - Average rate of VS territory referred to Annex I Habitats; the VSs have been grouped on the ground of the Bioclimatic belts [Cryorotemperate (Cry-tem), Orotemperate (Oro-tem), Supratemperate (Sup-tem), Mesotemperate (Mes-tem), Meso-Submediterranean (Mes/Sub-med), Mesomediterranean (Mes-med)], the Azonal VS are apart. Cryorotemperate and Orotemperate belts, both represented by only one VS, have been treated jointly.

altitudes (Cryoro- and Oro-temperate Bb); the differences are statistically significant (Kruskal-Wallis Test, $p<0.01$, Figure 2).

Data indicate that, inside the potential territory of each VS, there is an inverse proportion between the number of detected Habitats and the rate of surface covered by Habitats. When we represent this data clustered on a bioclimatic base, this inverse relationship is statistically significant (Kolmogorov-Smirnov Test, $p<0.05$, Figure 3). We can observe that the highest number of Annex I Habitats per VS is present in the lower Bioclimatic belts, especially in the Mesomediterranean (ranging from 12 to 15 Habitats), Mesotemperate (from 1 to 25) and Meso-Submediterranean (from 5 to 14). As concerns the Azonal VSs, they include 12 Habitats per VS on average. In all these cases, in spite of the remarkable Habitat number per VS, the surface detected as Habitat is very low compared to the whole VS surface. On the other side, the VSs located at the highest altitudes (Cryorotemperate and Orotemperate Bioclimatic belts) include only a very limited number of Habitats (1 and 2, respectively) but their potential surface is completely included into them (Figure 3).

If we measure the Habitat's rate of presence inside each VS, it can be considered as a sort of degree of "exclusivity". When we average this information with reference to VS groups according to the Bioclimatic belt, the differences among groups appear to be highly statistically significant (Kruskal-Wallis Test, $p<0.001$, Figure 4). Few Habitat types can be found exclusively in one or few VSs, showing very strict links to specific vegetational/ecological contexts. High levels of "exclusivity" can be noticed in the high altitude and azonal VSs and G. For instance, H6170 is exclusive to the Geoseries of the high altitude primary vegetation (Table 2), while H7230 (*Caricion davallianae*) is exclusive to the Geoseries of the montane carstic plains. Specific wetland Habitats like H3140, H3150, H3260, H7210, are exclusive to the "Geoseries of the Azonal, Peninsular-Italic, hydrophilous freshwater vegetation" while H3270 and H3280 can be found only in the "Geoseries of the Azonal, Peninsular-Italic, hygrophilous riparian vegetation". On the other side, there is a large number of Annex I Habitats showing a scattered distribution: a typical example can be H6210(*), represented by different phytosociological associations of secondary grasslands, which can develop as successional stages inside several VSs on different substrata and along a rather wide altitudinal range. It's also the case of H5130, H6210(*), H6220*, H6420, H91L0, H91M0, H9260, H92A0, H9340, H9540. Low levels of "exclusivity" can be found mostly in the Mesotemperate and Meso-Submediterranean Bioclimatic belts (Figure 4). In spite of a low level of exclusivity, these VSs host a very high number of Annex I Habitats, as already evident in Figure 3.

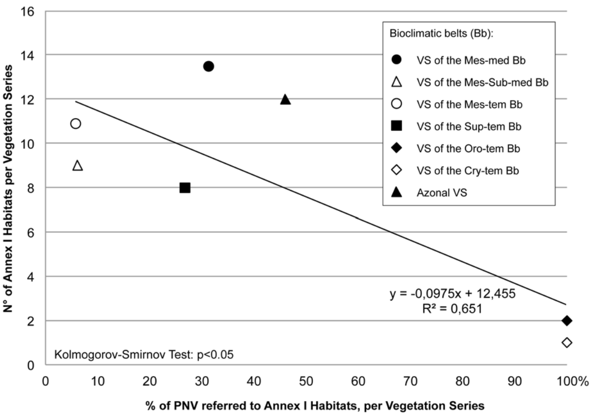

Fig. 3 - Average number of Annex I Habitats, confronted to the rate of PNV surface occupied by Habitats, for each VS; the VSs have been grouped and averaged on the basis of their Bioclimatic belt [Cryorotemperate (Cry-tem), Orotemperate (Oro-tem), Supratemperate (Sup-tem), Mesotemperate (Mes-tem), Meso-Submediterranean (Mes/Sub-med), Mesomediterranean (Mes-med)], the Azonal VS are apart.

Discussion

The overlay between VS and Habitat maps helped focusing on the weak points of Natura 2000 Network in Umbria, with reference to both Sites location and Habitats identification, offering a support in testing its suitability at the regional level. On the ground of the reported data, large gaps could be detected, showing that the potential biodiversity of the regional territory was not fully grasped during the process of Site selection. The result is that the current configuration is lacking in some peculiar aspects which, on the ground of specific studies, might have been referred to Annex I Habitats (Biondi *et al*., 2010a, 2010b). These "gap VSs" are either scarcely included in Natura 2000 Sites, or the mapped surface of their Habitats is dramatically low. In spite of this, they share a large number of ubiquist, not exclusive Habitats, reaching the highest number of Habitat types when compared to other bioclimatic areas. In fact, the gap density is more prominent in the VSs belonging to the Mesotemperate, Mesomediterranean and Meso-Submediterranean Bioclimatic belts, corresponding to the valleys and low-middle hilly areas. This can be easily understood when we consider that, at these latitudes, the anthropic processes and human settlement took place just in those areas, which for climatic and geo-morphologic reasons are the most profitable for agriculture, cattle-breeding and many other human activities connected to productivity (e.g. development of industry, transport and urban sprawl). We should not forget that human-driven land-use and land-cover changes are the main driving forces for biodiversity loss, and that the Mediterranean Region results nowadays one of the most drastically altered hotspots in the world, after a millenary history of anthropic disturbance (Sanderson *et al*., 2002; Lepers *et al*., 2005; Falcucci *et al*., 2006).

On the other side, the concept of "exclusivity", linking specific Habitats to few or one VSs, offers an extraordinary tool to evaluate the rarity and the peculiarity of a Habitat at the local scale. This is the case of the VSs and Geoseries located at the highest altitudes (Cryorotemperate and Orotemperate Bioclimatic belts), which include only a very limited number of Habitats (1 and 2, respectively), resulting totally exclusive of these VSs. Their potential surface is completely included into Natura 2000 Sites, and also in this case it is an obvious consequence of the historical land use, which spared large natural surfaces in the most inhospitable regions, less profitable for land exploitation due to climatic and geomorphological reasons.

Historical reasons for a lower Habitat density do not justify the omission of large regional areas, also considering that the Habitats Directive promotes measures not only to maintain but also to "restore the natural habitats" at a favourable status (European Commission, 1992). The phytosociological information and the concept of VS and PNV can be used to identify neglected aspects of the local diversity. The present study shows how even (or perhaps just) the most degraded VSs (those with reduced Habitat surface), although lacking in exclusive Habitats, appear to be the richest in Habitat variety. These extremely fragmented Habitats are those more at risk of decline in distribution or ecological function, both suitable criteria to detect critically endangered, endangered or vulnerable Habitats (Rodríguez *et al*., 2011), in complete analogy with the criteria adopted for species Red Lists (Mace *et al*., 2008; Rossi *et al*., 2014). Indeed, different portions of

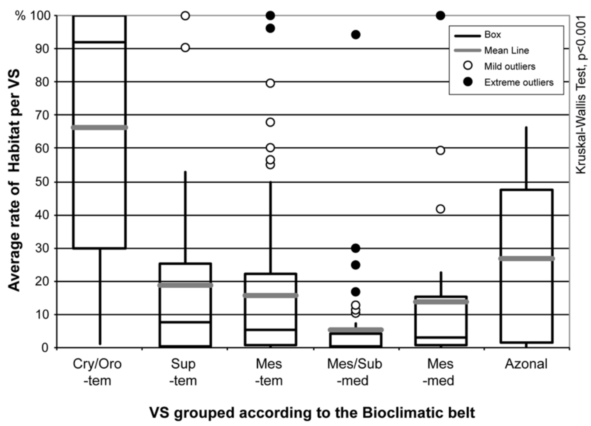

Fig. 4 - Average Habitat's rate of presence inside each VS, considered as a proxy of "exclusivity"; the VSs have been grouped and averaged on the basis of the Bioclimatic belt [Cryorotemperate (Cry-tem), Orotemperate (Oro-tem), Supratemperate (Sup-tem), Mesotemperate (Mes-tem), Meso-Submediterranean (Mes/Sub-med), Mesomediterranean (Mes-med)], the Azonal VS are apart.

a Habitat distribution range may differently contribute to its overall survival, giving rise to national and regional conservation responsibilities and priorities, as suggested with reference both to species (Schmeller *et al*., 2008a, 2008b, 2008c) and habitats (Schmeller *et al*., 2012).

Similarly to Mücher *et al*. (2009), this study combines a top-down approach (starting with a stratification of ecologic layers, e.g. climatic and geolithologic information, as the basis of the VS map) with a bottom-up approach (using high definition Habitat maps, based on vegetation relevés). In this light, the PNV stands as a precious and absolutely necessary tool to give a proper evaluation of the actual relevance of a Habitat at local level. The gap analysis can point out which VSs are under- or over-represented in Natura 2000 Network, and the knowledge about their successional stages can give robust information about Habitat future development, including restoration. Thanks to the predictive power of the VS, it is also possible to develop restoration projects of fragmented or lost Habitats, taking care of those landscapes which are at the moment the most vulnerable and endangered.

In the light of the discussed outcomes, methodological protocols should be developed case by case: no large-scale generalization is possible. The regional scale stands as a good compromise between detailed information and synthetic overview also because, at this scale, Habitat state and requirements may diverge from the national/supranational indications (Bensettiti *et al*., 2005). This type of approach might offer a good support for the development of a Red List of Habitats, aimed at assessing Habitats conservation status and conservation priorities. Species and Habitats Red Lists are the most commonly used tool for conservation priority assessment (IUCN, 2001; Mace *et al*., 2008; Rodríguez *et al*., 2011), although often the proposed methods of prioritization may remarkably differ among each other (Schmeller *et al*., 2008a). Schmeller *et al*. (2012) correctly emphasized the crucial role of national responsibilities in this process.

The present study shows that even a relatively small administrative Region (one of the smallest in Italy) is gifted with a large variety of Annex I Habitats. This implies a demanding task in order to fulfil the requests of Art. 17 (92/43/EEC Directive) about Habitats monitoring. In this light, Habitats prioritization based on PNV might be extremely profitable, in order to make an optimal use of the restricted financial support currently devoted to biodiversity conservation at national and international level.

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