

The species-specific monitoring protocols for plant species of Community interest in Italy

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Abstract

The results of a project for the identification of species-specific monitoring protocols for the Italian plant species protected under the Habitats Directive (Annexes II/IV/V) are presented. The project led to the development of 118 monitoring factsheets, providing an operational guidance for 107 vascular *taxa*, 10 bryophytes and 1 lichen *taxon*. Each factsheet includes information on the species (distribution, biology, ecology, conservation status, threats, *etc.*) and the description of field methodologies for the detection of the two main reporting parameters, *i.e.* population size and habitat quality. Practical information to plan field activities are also given. Protocols were designed to address the requirements of the European reporting system with the aim to standardize future monitoring activities, optimize efforts at national scale and overcome some current problems related to data heterogeneity and discrepancies from the EC standards. More than 60 botanists collaborated to identify the best practices and to design an operational field survey format through several stages of discussion and sharing. The protocols, developed by ISPRA and Scientific Societies and shared with the Italian institutions responsible for the Directive application, were published in a dedicated National handbook. The work provides a first uniform technical basis for future national monitoring plans.

Key words: conservation, EC-Habitats Directive, field methodologies, plant species monitoring, population size.

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Introduction

The reference framework of the project presented in this paper is the Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora, known as the Habitats Directive (HD hereafter), and its implementation in Italy. The HD and the Natura 2000 network with more than 27,000 sites, covering about 18% of the terrestrial surface of the EU (EC, 2015a; EEA, 2015), represent the core strategy of nature conservation and the most important tools aiming at protecting biodiversity in Europe (*e.g.* Balmford *et al.*, 2003; Maiorano *et al.*, 2007). In order to evaluate the effects of the conservation policies and the effectiveness of HD, the European Commission (EC) requires the assessment of the conservation status of species and habitats at national and biogeographical level. Monitoring habitats and species listed in the Annexes of the HD is a key step in the HD implementation, but also a mandatory action for Member States, arising from Article 11. Moreover, according to Article 17, Member States are required to report every 6 years on the main results of this survey. HD monitoring and reporting are not restricted to Natura 2000 sites, therefore data need to be collected both in and outside the network (Evans & Arvela, 2011).

Reporting under Article 17 follows a standard methodology and uses a format proposed by the EC and approved by Member States after discussion and consultation. The use of common standards and formats is necessary to harmonize the content of the National reports developed by Member States, and to allow the aggregation of data at European level (DG Environment, 2017). On the basis of the National reports indeed, the EC in collaboration with EEA (European Environment Agency) produces composite reports and makes them accessible to other EU institutions and to the public (EC, 2015b). These composite reports provide an overview of the status of the European biodiversity and represent a component for evaluating EU policy, in particular for measuring progress towards the 2020 targets set under the Biodiversity Strategy (EEA, 2015; EC, 2015b).

In the third Italian National Report, covering the period 2007-2012, the status of the species and habitats of Community interest was assessed using available knowledge and expert judgment (Genovesi *et al.*, 2014). The Italian Report reveals an increase in the quality of data and assessments compared to the past, but despite these significant advances, there are still some data gaps due to heterogeneity, inconsistency in collection methods, discrepancies from the HD reporting requests, lack of data for some parameters and a low percentage of information derived from *ad hoc* field surveys and long-term monitoring (Ercole & Giacanelli, 2014). A major cause of these problems is

the absence of a standardized monitoring and data collection program at a national level, both for vascular and non vascular flora (Ravera *et al.*, 2016; Fenu *et al.*, 2017).

To overcome several of these deficiencies and to improve monitoring systems for HD in Italy, an *ad hoc* project was set up in 2015, aimed to standardize future monitoring activities and to optimize efforts at national scale. A network of institutions (Italian Ministry for the Environment, Regions and Autonomous Provinces) and scientific societies with the coordination of the Italian National Institute for Environmental Protection and Research (ISPRA) has been organized with the main goal to identify nationwide shared monitoring protocols for habitats and species listed in the annexes of the HD.

In particular, for plant species of Community interest all activities were carried out through a scientific collaboration between ISPRA and SBI (Italian Botanical Society) with a further contribution of SLI (Italian Lichen Society), and led to the identification of species-specific monitoring protocols for all plant species listed in the HD. Protocols were designed to address the requirements of the European reporting system. Standardized data collection methods should lead to achieve comparable results and to overcome some current problems related to data heterogeneity and discrepancies from the EC standards and should allow greater repeatability and comparability over time. At the end of the project (October 2016) all protocols have been collected in a dedicated National handbook (Ercole *et al.*, 2016).

Main goals and organization of the project for plant species

The main aim of the project was to define nationwide shared monitoring protocols for Italian plant species of Community interest, consistent to the HD reporting requests and based on the best current scientific knowledge. The protocols were strongly focused on species-specific methodologies to measure/estimate the species population size and status.

Species monitoring is the regular observation and recording of changes in status and trend of a *taxon* in a certain territory and time interval. Beyond a purely scientific interest, the primary purpose of monitoring is to collect information useful in developing conservation policy, to examine the outcomes of management actions and guide management decisions (*e.g.* Fenu *et al.*, 2015). Moreover, monitoring should have further goals, such as detection of significant changes in resource abundance, assessment of the effects of management on population/community dynamics, and providing suggestions for applied research questions. Finally, monitoring data can be used to assess the conservation

status or to predict the effects of various management practices on population size, condition, stage distribution (including seed production and/or seedlings development) and demographic processes (e.g. survivorship, growth, seedling recruitment; Menges & Gordon, 1996; Barni *et al.*, 2013; Fenu *et al.*, 2015). The parameters selected and the frequency of measurement will depend on specific management or conservation objectives, on initial assessment of threat or need, on the biology of the species and on available resources (Menges & Gordon, 1996; Fenu *et al.*, 2015; Giovino *et al.*, 2015). However, because time and resources for monitoring activities are generally limited also for HD plants, only few plant populations are involved with an adequate monitoring program and generally hasty estimation of abundance or extent of populations prevails. As a consequence, few experiences, always at the regional level and often focused on narrow endemic plant species (e.g., Fenu *et al.*, 2011, 2015; Campisi

et al., 2014; Plume *et al.*, 2015; Troia & Lansdown, 2016), were carried out so far.

The project activities began in April 2015; more than 60 botanists pertaining to different universities and research institutes were involved. The network was headed by an ISPRA-SBI coordination group and organized into 12 units: 10 units for vascular plants and two for non-vascular plants (Fig. 1). The project was carried out through several stages of discussion and sharing, making progressive improvement steps to the identification of the best practice and to provide complete “monitoring factsheets”, concise and operational.

Firstly, the checklist of the Italian HD plant *taxa* has been defined and updated following the current knowledge and the latest taxonomic and systematic studies (Rossi *et al.*, 2016). Then, monitoring factsheet format and contents have been carefully chosen in order to have a first draft common framework for the involved researchers. In addition, a “survey format” to test in the field the monitoring techniques was elaborated and each working group began to work on the assigned *taxa*.

The monitoring protocols were identified for all the *taxa* and tested in the field for a set of target species, selected on the basis of their representativeness of different reproductive/propagative strategies and distribution patterns.

The protocols were submitted to the Italian institutions responsible for the HD implementation and application to be reviewed: in early 2016 all draft factsheets were shared for comments and suggestions, first with the Italian Ministry for the Environment and then with Regions and Autonomous Provinces, as responsible institutions for monitoring under HD. After an extensive review and implementation work, the retail version of the factsheets was completed.

Project findings

Update of the list of taxa

Plant species to be monitored under the HD are all those listed in Annexes II, IV and V distributed on the Italian territory. For the purpose of the project the list of Italian plant *taxa* to be monitored under HD has been revised and updated on the basis of recent studies, also by a taxonomic point of view.

In addition to the 109 *taxa* considered in the third Italian Report (Ercole & Giacanelli, 2014; Fenu *et al.*, 2017), five other vascular species, listed in Annexes II/IV, were also included in the project: *Botrychium simplex* E.Hitchc., *Centranthus amazonum* Fridl. & A.Raynal, *Elatine gussonei* (Sommier) Brullo, Lanfr., Pavone & Ronsiv., *Klasea lycopifolia* (Vill.) Á.Löve & D.Löve [HD name: *Serratula lycopifolia* (Vill.) A.Kern], *Jacobaea vulgaris* Gaertn. subsp. *gotlandica* (Neuman) B.Nord [HD name: *Senecio jacobea* L.

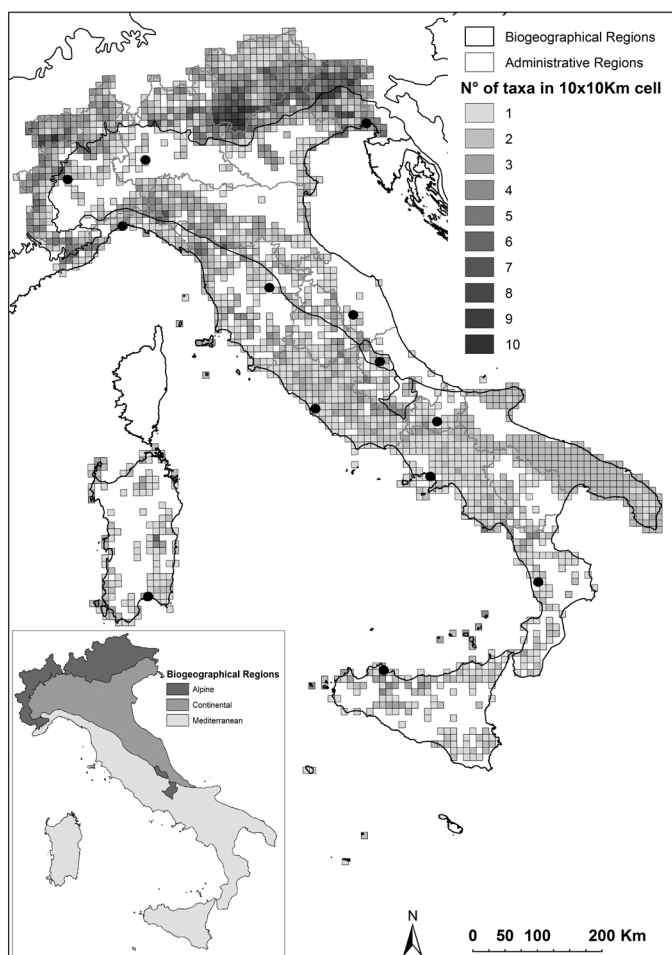


Fig. 1 - Geographic location of the main working groups involved in the project (black dots), overlapping the density map of the Italian plant species of Community interest (Annexes II, IV, V; distribution data from the III Italian Report). The boundaries of the Biogeographical and administrative Italian Regions were also indicated.

subsp. *gotlandicus* (Neuman) Sterner]. Although their presence in Italy is certain, they had not been previously included in the checklist ex Art.17.

Four HD plants previously reported for Italy but currently considered probably extinct (Rossi et al., 2016) have also been included in the project. This choice was made according to a precautionary principle and in view of a possible future rediscovery of these plants (*Bromus grossus* Desf. ex DC., *Coleanthus subtilis* (Tratt.) Seidl, *Mandragora officinarum* L., *Thesium ebracteatum* Hayne).

The updated list includes a total of 118 *taxa*: 107 vascular plants, 10 bryophytes and one lichen *taxon*; 115 of these *taxa* are protected by the HD at the species level and 3 at the genus or subgenus level (*i.e.* *Cladonia* L. subgenus *Cladina* (Nyl.) Vain., *Sphagnum* L. sp. pl., *Lycopodium* L. sp. pl.).

According to the latest updates of the Italian endemic flora (Peruzzi et al., 2014, 2015), about half of the Italian HD *taxa* are endemic. Among the vascular plants, 54 species are endemic to Italy, two are endemic to Sardinia and Corsica, one to Sicily and Malta and three *taxa* have subspecies endemic to Italy. Among bryophytes *Riccia breidleri* Jur. ex Steph. is an alpine endemism, the only one among non-vascular plants (Aleffi et al., 2008).

Field survey format and species-specific monitoring protocols

The published handbook (Ercole et al., 2016) contains the species-specific protocols and specific field survey formats (for vascular plants, bryophytes and lichens) developed in the project. The use of standardized protocols and survey formats is essential in order to ensure uniformity in spatial terms (data recorded in the same way in different areas of the territory, such as Regions), and in temporal terms (data recorded with the same methods in different years and from different detectors). The survey formats have been designed to be in compliance with the requirements of HD reporting, scientifically rigorous, applicable both at local and national level, suitable to ensure collection of homogeneous data and repeatable over time.

The monitoring protocols developed for each of the 118 *taxa* were tested in the field on a set of 12 target species, identified according to representativeness criteria for life forms, phenology, ecology and biogeography (Tab. 1). Among them, *taxa* with very limited/narrow distribution and *taxa* with wide distribution were included. Field surveys allowed to adjust the methodology across the different groups of botanists involved in the project, to verify applicability of the protocols and to improve the survey formats.

For each *taxon* a specific monitoring factsheet has been filled. A single factsheet has been realized even for *taxa* protected at the *genus* level, and in the cases of

species represented in Italy by two or more subspecies (*Anchusa crispa* Viv., *Asplenium adulterinum* Milde, *Dianthus rupicola* Biv., *Gentiana lutea* L. and *Stipa austroitalica* Martinovsky), since in both cases a comprehensive HD reporting is required.

The factsheet format includes two sections, a first one with information on the species (descriptive section) and a second one dedicated to the monitoring. The former contains relevant information such as: conservation status and trend *sensu* HD derived from the third Italian Report (Genovesi et al., 2014), European (Bilz et al., 2011) and National (Rossi et al., 2016) IUCN assessments, chorotype, distribution in Italy, major biological characteristics, ecological requirements, plant communities and threats. In particular, plant communities where each plant species grows and their syntaxonomical attribution (for vascular plants mainly according to Biondi et al., 2014) have been briefly described, as relevant information for plant species, although HD reporting does not require it. Since many of the species are threatened by specific and relevant pressures, even the description of the identified threats for each *taxon* has been reported.

Each factsheet also contains the distribution map of the *taxon*: 98 maps are the ones already produced in the third Report (standard European grid 10×10 km), 5 maps are derived from the third Report with meaningful updates, 7 maps are brand-new elaborated on the same standard grid, and 8 are regionally based maps (Administrative Region of presence/extinction). Moreover, original photos contribute to illustrate morphology and habitat of the *taxon*.

The monitoring section includes the description of field methodologies for the detection of the two main HD parameters, *i.e.* population size and habitat for the species. Concerning population size, for each species the methodologies and the following information are provided: minimum percentage of populations to be monitored; number, size, and criteria for *plot* placement; specific parameters to be detected (counts or estimates) including number of individuals, *i.e.* *genet* and/or *ramet*, which is not always easy to determine. There are several plants that use vegetative reproduction and therefore generate clonal populations, in which only the number of *ramet* can be estimated (*e.g.* *Lamyropsis microcephala* (Moris) Dittrich & Greuter, *Arnica montana* L., *Gentiana lutea* L., *Ribes sardoum* Martelli). In these cases it is extremely difficult, or impossible, to establish the exact number of individuals or *genet*.

Other parameters detected are the number of colonies/clumps (*e.g.* for ferns as *Asplenium adulterinum* Milde and *Vandenboschia speciosa* (Willd.) G.Kunkel [HD name: *Trichomanes speciosum* Willd.]) and the extent of covered area (for bryophytes, lichens, hydrophytes and plants with high clonal propagation, *e.g.*

Tab. 1 - Target plant species selected for the field test.

<i>Taxon</i>	<i>Distribution</i>	<i>Life form</i>	<i>Habitat</i>	<i>No. populations monitored</i>	<i>Regions involved</i>
<i>Androsace mathildae</i> Levier	Endemic to Central Apennines	Chamaephyte	Montane limestone cliffs	1 (representative population)	Abruzzo
<i>Armeria helodes</i> F.Martini & Poldini	Narrow endemic to Friuli Venezia Giulia	Hemicryptophyte	Alkaline fens of peaty soil that are saturated in water and rich in calcium and magnesium	7 (all populations)	Friuli Venezia Giulia
<i>Eo Kochia saxicola</i> (Guss.) Freitag & G.Kadereit [HD name: <i>Bassia saxicola</i> (Guss.) A.J.Scott]	Endemic to South Italy (Tyrrhenian coast)	Chamaephyte	Maritime rocks and calcareous or volcanic cliffs	5 (all populations)	Campania, Sicilia
<i>Cypripedium calceolus</i> L.	Eurasian	Geophyte	Open woodland, scrub under conifers, forest margins, grasslands	3 (representative populations)	Valle d'Aosta, Piemonte, Lombardia, Trentino-Alto Adige, Veneto, Friuli Venezia Giulia, Abruzzo
<i>Gentiana lutea</i> L.	South Europe	Geophyte	Mountain grasslands and meadows	11 (representative populations covering the entire distribution in Italy)	Peninsular Italy, Sardegna
<i>Isoetes malinverniana</i> Ces. & De Not.	Endemic to North Italy (Po plain)	Hydrophyte	Freshwater: clear, fresh and running spring water	14 (all actual populations) + 5 (extinct)	Piemonte, Lombardia
<i>Lamyropsis microcephala</i> (Moris) Dittrich & Greuter	Narrow endemic to Sardegna	Geophyte	Montane dwarf shrub and steppe vegetation	4 (only known populations)	Sardegna
<i>Acis nicaeensis</i> (Ardoino) Lledó, A.P.Davis & M.B. Crespo [HD name: <i>Leucojum nicaeense</i> Ardoino]	Endemic to Maritime Alps (France and in the northwest of Italy's border)	Geophyte	Rocky areas and barren slopes on stony soils	1 (only known population)	Liguria
<i>Marsilea quadrifolia</i> L.	Eurasian	Hydrophyte	Freshwater: ponds, rice fields and ditches	6 (representative populations)	Piemonte, Lombardia, Veneto, Trentino-Alto Adige, Emilia-Romagna, Toscana
<i>Primula palinuri</i> Petagna	Endemic to South Italy (Tyrrhenian coast)	Geophyte	Northern, northwestern or northeastern slopes on calcareous substrate with neutral pH	2 (all populations)	Campania, Basilicata, Calabria
<i>Ribes sardoum</i> Martelli	Narrow endemic to Sardegna	Nano-Phanerophyte	Mountain areas on calcareous substrates	1 (only known population)	Sardegna
<i>Silene hicsiae</i> Brullo & Signor.	Endemic to the Aeolian Islands	Chamaephyte	Rocky slopes of small volcanic islets	1 (main population)	Sicilia

Marsilea quadrifolia L.). In some cases, the number of flowering/fruited individuals or other specific data can also be required.

The protocols may differ greatly depending on both the extent of the populations of each species and their biological and ecological characteristics. In Italy, many HD plant species have a restricted distribution area and small populations. In these cases (which are usually the better known and investigated) it is recommended to count all the individuals. For populations with a high number of individuals the methodologies usually involve counts on a representative number of plots, in order to sample a significant portion of the population (at least 10%) and to obtain subsequently the total estimate. In the case of more widespread species (e.g. *Ruscus aculeatus* L.), the population size can be estimated calculating the number of 1×1 km grid cells, in conformity to what has been recently specified by the European Commission for Annex V species (DG Environment, 2017).

The factsheet also includes some practical informa-

tion to plan field activities, specifically: monitoring frequency requested in a year and in the six years between two reporting cycles, best period for sampling (months of flowering, fruiting, etc.), number of requested working days per year, minimum number of people to be employed in field surveys.

Concluding remarks

Despite monitoring activities are the basis for many national and international conventions and directives and represent a fundamental tool for natural resource management and conservation, currently an Italian national monitoring system does not exist yet. Recommendations on how to monitor biodiversity are numerous (e.g. Nimis *et al.*, 2002; Balmford *et al.*, 2003; Mace, 2005; Baiamonte *et al.*, 2015; Fenu *et al.*, 2015; Evangelista *et al.*, 2016), but are still insufficiently taken into account at a National scale. Although several experiences have been realized at the local level, long-term monitoring data on individual taxa are available

only in few cases (Fenu *et al.*, 2017).

Italy hosts a high number of plant *taxa* of Community interest (exceeded only by Spain and Portugal among the Member States), therefore monitoring efforts are particularly demanding. Additionally, the high endemism rate of the Italian plant species of Community interest, about 50% of the total, determines an extraordinary national responsibility in conservation.

The last Italian Report *ex Art.17* showed a negative situation for our HD plant species with nearly half of them declared in an unfavourable conservation status (Ercole & Giacanelli, 2014; Fenu *et al.*, 2017), confirming the results of the Italian IUCN assessments of policy species (Rossi *et al.*, 2014, 2016). Moreover the trend of several *taxa* suggests that many of these species might move to categories of higher extinction risk in the coming years (Fenu *et al.*, 2017). Such evidences demonstrate that the efforts undertaken in the last 20 years are still insufficient to maintain many *taxa* at a favourable conservation status. Significant work still remains to achieve the HD conservation targets and monitoring activities are crucial to reach the goal.

In conclusion, this project provides for the first time uniform technical bases for future national HD monitoring plans. The species-specific protocols identified for Italian plant species of Community interest can help to overcome the lack of shared standards and some current problems related to data heterogeneity, allowing greater replicability and comparability of data collection over time. It is also interesting to note that the requirements of the HD monitoring (*e.g.* for demographic data) may partly overlap and coincide with the needs related to research projects and specific studies. At the same time further scientific research will contribute to the improvement of species-specific monitoring protocols that will gradually become more accurate and useful for HD monitoring purposes.

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References

- Aleffi M., Tacchi R. & Cortini Pedrotti C., 2008. Checklist of the Hornworts, Liverworts and Mosses of Italy. *Bocconea* 22: 1-256.
- Baiamonte G., Domina G., Raimondo F.M. & Bazan G., 2015. Agricultural landscapes and biodiversity conservation: a case study in Sicily (Italy). *Biodiversity and Conservation* 24 (13): 3201-3216.
- Balmford A., Green R.E. & Jenkins M., 2003. Measuring the changing state of nature. *Trends in Ecology & Evolution* 18 (7): 326-330.
- Barni E., Minuzzo C., Gatto F., Lonati M., Abeli T., Amosso C., Rossi G. & Siniscalco C., 2013. Estimating influence of environmental quality and management of channels on survival of a threatened endemic quillwort. *Aquatic Botany* 107: 39-46.
- Bilz M., Kell S.P., Maxted N. & Lansdown R.V., 2011. European Red List of Vascular Plants. Publications Office of the European Union, Luxembourg.
- Biondi E., Blasi C., Allegranza M., Anzellotti I., Azzella M.M., Carli E., Casavecchia S., Copiz R., Del Vico E., Facioni L., Galdenzi D., Gasparri R., Lasen C., Pesaresi S., Poldini L., Sburlino G., Taffetani F., Vagge I., Zitti S. & Zivkovic L., 2014. Plant communities of Italy: The Vegetation Prodrome. *Plant Biosystems* 148: 728-814.
- Campisi P., Lo Re M.G., Geraci A., Troia A. & Dia M.G., 2014. Studies on the Sicilian populations of *Anacolia webbii* (Mont.) Schimp. (*Bartramiaceae*, *Bryophyta*), rare moss in Europe. *Plant Biosystems* 148: 874-884.
- DG Environment, 2017. Reporting under Article 17 of the Habitats Directive: Explanatory notes and guidelines for the period 2013-2018. Brussels. Pp 188. http://cdr.eionet.europa.eu/help/habitats_art17/index_html
- EC, 2015a. Natura 2000 Barometer European Commission, Brussels. http://ec.europa.eu/environment/nature/natura2000/barometer/index_en.htm (accessed 9th, Dec. 2016).
- EC, 2015b. Report from the Commission to the Council and the European Parliament. The State of Nature in the European Union. Report on the status of and trends for habitat types and species covered by the Birds and Habitats Directives for the 2007-2012 period as required under Article 17 of the Habitats Directive and Article 12 of the Birds Directive. Brussels, COM/2015/0219 final.
- EEA, 2015. State of nature in the EU - Results from reporting under the nature directives 2007-2012. EEA Technical report No 2/2015. <http://www.eea.europa.eu/publications/state-of-nature-in-the-eu/>
- Ercole S. & Giacanelli V., 2014. Flora. In: Genovesi P., Angelini P., Bianchi E., Dupré E., Ercole S., Giacanelli V., Ronchi F. & Stoch F. (Eds.), *Specie e habitat di interesse comunitario in Italia: distribuzione, stato di conservazione e trend*: 17-69. ISPRA, Serie Rapporti 194/2014.
- Ercole S., Giacanelli V., Bacchetta G., Fenu G. & Genovesi P. (Eds.), 2016. Manuali per il monitoraggio di specie e habitat di interesse comunitario (Direttiva 92/43/CEE) in Italia: specie vegetali. ISPRA, Serie Manuali e linee guida, 140/2016. http://www.isprambiente.gov.it/public_files/direttiva-habitat/Manuale-140-2016.pdf
- Evangelista A., Frate L., Stinca A., Carranza M.L. & Stanisci A., 2016. VIOLA - the vegetation databa-

- se of the central Apennines: structure, current status and usefulness for monitoring Annex I EU habitats (92/43/EEC). *Plant Sociology* 53 (2): 47-58.
- Evans D. & Arvela M., 2011. Assessment and reporting under Article 17 of the Habitats Directive. Explanatory Notes & Guidelines for the period 2007-2012. European Topic Centre on Biological Diversity. http://bd.eionet.europa.eu/activities/Reporting/Article_17/reference_portal
- Fenu G., Bacchetta G., Giacanelli V., Gargano D., Montagnani C., Orsenigo S., Cogoni D., Rossi G., Conti F., Santangelo A., Pinna M.S., Bartolucci F., Domina G., Oriolo G., Blasi C., Genovesi P., Abeli T. & Ercole S., 2017. Conserving plant diversity in Europe: outcomes, criticisms and perspectives of the Habitats Directive application in Italy. *Biodiversity and Conservation* 26 (2): 309-328.
- Fenu G., Cogoni D., Pinna M.S. & Bacchetta G., 2015. Threatened Sardinian vascular flora: a synthesis of 10 years of monitoring activities. *Plant Biosystems* 149: 473-482.
- Fenu G., Mattana E. & Bacchetta G., 2011. Distribution, status and conservation of a critically endangered, extremely narrow endemic: *Lamyropsis microcephala* (Asteraceae) in Sardinia. *Oryx* 42: 180-186.
- Genovesi P., Angelini P., Bianchi E., Dupré E., Ercole S., Giacanelli V., Ronchi F. & Stoch F., 2014. Specie e habitat di interesse comunitario in Italia: distribuzione, stato di conservazione e trend. ISPRA, Serie Rapporti 194/2014.
- Giovino A., Domina G., Bazan G., Campisi P. & Scibetta S., 2015. Taxonomy and conservation of *Pan-cratiium maritimum* (Amaryllidaceae) and relatives in the Central Mediterranean. *Acta Botanica Gallica* 162: 289-299.
- Mace G.M., 2005. Biodiversity: an index of intactness. *Nature* 434 (7029): 32-33.
- Maiorano L., Falcucci A., Garton E.O. & Boitani L., 2007. Contribution of the Natura 2000 network to biodiversity conservation in Italy. *Conservation Biology* 21: 1433-1444.
- Menges E.S. & Gordon D.R., 1996. Three Levels of Monitoring Intensity for Rare Plant Species. *Natural Areas Journal* 16: 227-237.
- Nimis P.L., Scheidegger C. & Wolseley P.A. (Eds.), 2002. Monitoring with Lichens - Monitoring Lichens. NATO Science series IV: Earth and Environmental Sciences. Kluwer Academic Publishers. The Netherlands.
- Peruzzi L., Conti F. & Bartolucci F., 2014. An inventory of vascular plants endemic to Italy. *Phytotaxa* 168: 1-75.
- Peruzzi L., Domina G., Bartolucci F., Galasso G., Peccenini S., Raimondo F.M., Albano A., Alessandrini A., Banfi E., Barberis G., Bernardo L., Bovio M., Brullo S., Brundu G., Brunu A., Camarda I., Carta L., Conti F., Croce A., Iamonico D., Iberite M., Iiriti G., Longo D., Marsili S., Medagli P., Pistarino A., Salmeri C., Santangelo A., Scassellati E., Selvi F., Soldano A., Stinca A., Villani M.C., Wagensommer R.P. & Passalacqua N.G., 2015. An inventory of the names of vascular plants endemic to Italy, their *loci classici* and types. *Phytotaxa* 196 (1): 1-217.
- Plume O., Raimondo F.M. & Troia A., 2015. Hybridization and competition between the endangered sea marigold (*Calendula maritima*, Asteraceae) and a more common congener. *Plant Biosystems* 149: 68-77.
- Ravera S., Isocrono D., Nascimbene J., Giordani P., Benesperi R., Tretiach M. & Montagnani C., 2016. Assessment of the conservation status of the mat-forming lichens *Cladonia* subgenus *Cladina* in Italy. *Plant Biosystems* 150 (5): 1010-1022.
- Rossi G., Montagnani C., Abeli T., Gargano D., Peruzzi L., Fenu G., Magrini S., Gennai M., Foggi B., Wagensommer R. P., Ravera S., Cogoni A., Aleffi M., Alessandrini A., Bacchetta G., Bagella S., Bartolucci F., Bedini G., Bernardo L., Bovio M., Castello M., Conti F., Domina G., Farris E., Gentili R., Gigante D., Peccenini S., Persiani A.M., Poggio L., Prosser F., Santangelo A., Selvaggi A., Villani M.C., Wilhalm T., Zappa E., Zotti M., Tartaglino N., Ardenghi N.M.G., Blasi C., Raimondo F.M., Venturella G., Cogoni D., Puglisi M., Campisi P., Miserere L., Perrino E.V., Strumia S., Iberite M., Lucchese F., Fabrini G. & Orsenigo S., 2014. Are Red Lists really useful for plant conservation? The New Red List of the Italian Flora in the perspective of National Conservation policies. *Plant Biosystems* 148 (2): 187-190.
- Rossi G., Orsenigo S., Montagnani C., Fenu G., Gargano D., Peruzzi L., Wagensommer R.P., Foggi B., Bacchetta G., Domina G., Conti F., Bartolucci F., Gennai M., Ravera S., Cogoni A., Magrini S., Gentili R., Castello M., Blasi C. & Abeli T., 2016. Is legal protection sufficient to ensure plant conservation? The Italian Red List of policy species as a case study. *Oryx* 50 (03): 431-436.
- Troia A. & Lansdown R., 2016. The first confirmed population of the globally endangered *Pilularia minuta* (Marsileaceae) in Sicily. *Webbia* 71 (2): 283-286.