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Research Article

New national and regional Annex I Habitat records: from #158 to #167*

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Abstract

In this contribution, 10 records with new data concerning the distribution of 9 different Annex I Habitats in Italy are reported. In detail, they include 6 new occurrences in Natura 2000 Sites and 11 new cells in the EEA 10 km × 10 km Reference grid, referring to the Administrative Regions of Apulia, Latium, Lombardy, Piedmont, Sicily, Umbria, and Veneto.

Keywords

Monitoring, vegetation, 3220, 3270, 5210, 6110*, 6220*, 6510, 7220*, 8230, 91M0

* Topical Collection: "Towards 2030: efforts in habitat recording and the reporting cycle of the Habitats Directive - A scientific collection for habitat conservation".

Introduction

This is the 15th standardized contribution reporting data on Annex I Habitats distribution in Italy. The records presented here are new occurrences compared to the results of the 4th Report ex-Art. 17 on Annex I Habitat Monitoring in Europe, delivered in 2019 and available on the Eionet Central Data Repository (Eionet 2019). This contribution represents the last update on habitat distribution before the release of the official results of the 5th Annex I Habitat Monitoring Report (2019–2024); at present, most of the data provided by the EU Members are labelled as "technically accepted" (Reportnet 2026). As usual, the related phytosociological relevés will be archived in the national vegetation database "VegItaly" (Gigante et al. 2012; Landucci et al. 2012).

Habitats records

Following the New Habitat Record editorial guidelines of Gigante et al. (2019), which was recently updated (https://ved.arphahub.com/topical_collection/291/), detailed descriptions of the Annex I habitats in their sites of occurrences are provided. An overview of the records is provided in Table 1. Suppl. material 1 and 2 include the habitat phytosociological relevés and related maps and figures, respectively. Mapping was carried out using QGIS Geographic Information System (QGIS.org 2020).

#158. Annex I Habitat: 3220 Alpine rivers and the herbaceous vegetation along their banks (Nota G, Volpe J, Marengo G)

EUNIS Classification system: U71 – Unvegetated or sparsely vegetated gravel bars in montane and alpine regions (EEA 2021).
Biogeographical Region: Alpine.
National Habitat Checklist of reference: Italian Interpretation Manual of the Directive 92/43/EEC Habitats (Biondi et al. 2009).
Phytosociological reference: *Epilobion fleischeri* G. Braun-Blanquet ex Br.-Bl. 1949, *Epilobietalia fleischeri* Moor 1958, *Thlaspietea rotundifolii* Br.-Bl. 1948 (Biondi and Blasi 2015; Mucina et al. 2016).
Geographic information: Italy, Piedmont, Torino, Bobbio Pellice, Conca del Prà, 1709 m a.s.l., Coordinates: 44.767410°N, 7.040497°E (Suppl. material 1: table S1, Rel. 1); *ibidem*, 1708 m a.s.l., Coordinates: 44.767637°N, 7.040076°E (Suppl. material 1: table S1, Rel. 2); *ibidem*, 1707 m a.s.l., Coordinates: 44.768617°N, 7.040919°E (Suppl. material 1: table S1, Rel. 3); *ibidem*, 1704 m a.s.l., Coordinates: 44.769547°N, 7.042189°E (Suppl. material 1: table S1, Rel. 4); *ibidem*, 1701 m a.s.l., Coordinates: 44.771250°N, 7.042973°E (Suppl. material 1: table S1, Rel. 5).
Cell ID in the EEA reference grid: 10kmE408N241 (Suppl. material 2: fig. S1).
Natura 2000 Site Code: SAC IT1110032 "Prà - Barant".
Phytosociological table: Suppl. material 1: table S1; nomenclature and taxa delimitation according to Portal to the Flora of Italy (2026).
Notes: The habitat develops along the gravel bed of the Pellice stream within a wide flat basin (Conca del Prà). In this sector, the streambed widens over a stretch of about 1.2 km, reaching a lateral extension of up to 100 m and covering a total area of approximately 8 ha. Vegetation of the *Epilobion fleischeri* colonizes extensive portions of the streambed (Suppl. material 2: fig. S2), forming species-rich communities (up to 50 species per 16 m^2, Rel. 3). The colonization of some riverbed areas by shrubby willows (*Salix purpurea*) and young larches indicates natural succession towards more mature vegetation communities, which is nevertheless constrained by the high fluvial dynamism.

#159. Annex I Habitat: 3270 Rivers with muddy banks with *Chenopodion rubri* p.p. and *Bidention* p.p. vegetation (Pappagallo G)

EUNIS Classification system: Q61 – Periodically exposed shore with stable, eutrophic sediments with pioneer or ephemeral vegetation (EEA 2021).
Biogeographical Region: Mediterranean.
National Habitat Checklist of reference: Italian Interpretation Manual of the Directive 92/43/EEC Habitats (Biondi et al. 2009).
Phytosociological reference: *Bidention tripartitae* Nordhagen ex Klika et Hadač 1944, *Bidentetalia* Br.-Bl. et Tx. ex Klika et Hadač 1944, *Bidentetea* Tx. et al. ex von Rochow 1951 (Mucina et al. 2016).
Geographic information: Italy, Apulia, Foggia, Roseto Valfortore, Valle Ciccone, Fortore River, 492 m a.s.l., Coordinates: 41.375526°N, 15.078105°E (Suppl. material 1: table S2, Rel. 1); *ibidem*, 490 m a.s.l., Coordinates: 41.375211°N, 15.076156°E (Suppl. material 1: table S2, Rel. 2); *ibidem*, 487 m a.s.l., Coordinates: 41.376064°N, 15.074475°E (Suppl. material 1: table S2, Rel. 3).
Cell ID in the EEA reference grid: 10kmE474N204 (Suppl. material 2: fig. S3).
Natura 2000 Site Code: Currently not included in any Natura 2000 site (but in proximity (< 1.5 km) to the boundaries of the SAC IT9110003 "Monte Cornacchia - Bosco di Faeto").
Phytosociological table: Suppl. material 1: table S2; nomenclature and taxa delimitation according to Portal to the Flora of Italy (2026).
Notes: Currently, the occurrence of habitat 3270 in the Dauno-Sannitic sub-region is reported along the Molise course of the Fortore River (Cell ID 10kmE473N207 and 10kmE474N207; Eionet 2019), but not on the Apulian side (Biondi et al. 2009). In the study area, located in the upper course of the Fortore River (Valle Ciccone), the riverbed shows the presence of lithic material, including large clasts, derived from fluvial erosion processes. The

Table 1. Synthetic overview of the newly reported data.

NHR	Hab ID	Hab name	Cell ID	Country	BR	N2000 Site	Authors
#158	3220	Alpine rivers and their ligneous vegetation with *Myricaria germanica*	10kmE408N241	Italy	ALP	IT1110032	Nota G, Volpe J, Marengo G
#159	3270	Rivers with muddy banks with *Chenopodion rubri* p.p. and *Bidention* p.p. vegetation	10kmE474N204	Italy	MED	-	Pappagallo G
#160	5210	Arborescent matorral with *Juniperus* spp.	10kmE462N203, 10kmE461N204	Italy	MED	IT6040043	Di Pietro R, Proietti E
#161	6110*	Rupicolous calcareous or basophilic grasslands of the *Alysso-Sedion albi*	10kmE451N217	Italy	MED	IT5220008	Bonini F, Grassi A, Gigante D
#162	6220*	Pseudo-steppe with grasses and annuals of the *Thero-Brachypodietea*	10kmE491N200	Italy	MED	-	Perrino EV, La Rotonda P, Longo G
#163	6510	Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*)	10kmE449N253	Italy	CON	-	Preo SM, Favarin S, Masiero M
#164			10kmE439N248	Italy	CON	IT3210012	Villani M, Marchesin M
#165	7220*	Petrifying springs with tufa formation (*Cratoneurion*)	10kmE432N249	Italy	CON	-	Patera G
#166	8230	Siliceous rock with pioneer vegetation of the *Sedo-Scleranthion* or of the *Sedo albi-Veronicion dillenii*	10kmE413N248	Italy	ALP	-	Lonati M, Mainetti A, Pittarello M
#167	91M0	Pannonian-Balkanic turkey oak-sessile oak forests	10kmE462N165	Italy	MED	ITA020007, ITA020048	Gianguzzi L, Rigoglioso A, Caldarella O

rocky material in the riverbed promotes the formation of debris barriers which, during low-flow conditions, lead to the deposition of fine, nutrient-rich sediments originating from the surrounding agricultural fields. These conditions favor the establishment of summer-annual pioneer vegetation typical of the order *Bidentetalia* Br.-Bl. et Tx. ex Klika et Hadač 1944 (Mucina et al. 2016).

The analysis of the three attached relevés (Suppl. material 1: table S2) highlights two main aspects: i) the floristic composition, characterized by the presence of numerous alien species, a phenomenon frequently reported as typical of this habitat (Biondi et al. 2009); ii) the low dominance values (r, +, 1) recorded for species of the order *Bidentetalia*, most likely due to the timing of the surveys, which were carried out in late October (i.e., at the end of the growing season of many of these herbaceous species and close to the limit of the optimal sampling period for this habitat; Lastrucci 2016) (Suppl. material 2: fig. S4). For this reason, future monitoring campaigns should repeat the surveys in this area during the spring–summer season, when the diagnostic species of this vegetation type reach their optimal development. Such monitoring would also allow a better assessment of the spatial dynamics of this habitat, which is known to undergo spatial modifications over time due to periodic flood events (Biondi et al. 2009).

#160. Annex I Habitat: 5210 Arborescent matorral with *Juniperus* spp. (Di Pietro R, Proietti E)

EUNIS Classification system: S5131 – Prickly juniper (*Juniperus oxycedrus*) arborescent matorral (EEA 2021).
Biogeographical Region: Mediterranean.
National Habitat Checklist of reference: Italian Interpretation Manual of the Directive 92/43/EEC Habitats (Biondi et al. 2009).
Phytosociological reference: *Cytision sessilifolii* Biondi in Biondi et al. 1989, *Paliuretalia* Trinajstić 1978, *Crataego-Prunetea* Tx. 1962 (Mucina et al. 2016).
Geographic information: Italy, Latium, Formia municipality (LT), Monti Aurunci, Monte Mesole, 1000 m a.s.l., Coordinates: 41.311944°N, 13.591619°E (Suppl. material 1: table S3, Rel. 1); Italy, Latium, Pontecorvo municipality (FR), Monte le Festole, 865 m a.s.l., Coordinates: 41.400655°N, 13.561154°E (Suppl. material 1: table S3, Rel. 2).
Cell ID in the EEA reference grid: 10kmE462N203 (Suppl. material 1: table S3, Rel. 1); 10kmE461N204 (Suppl. material 1: table S3, Rel. 2) (Suppl. material 2: fig. S5).
Natura 2000 Site Code: SPA IT6040043 "Monti Ausoni e Aurunci".
Phytosociological table: Suppl. material 1: table S3; nomenclature and taxa delimitation according to Portal to the Flora of Italy (2026).
Notes: The communities identified as belonging to habitat 5210 are found in the montane bioclimatic belt of the Aurunci Mountains, within the boundaries of the Regional Natural Park, and are characterized by *Juniperus deltoides* as the dominant species. *Juniperus deltoides* was described as a species poorly discernible morphologically from *Juniperus oxycedrus*, whereas it exhibits a different composition of essential oil (Roma-Marzio et al. 2017). According to Bartolucci et al. (2018), only *Juniperus deltoides* occurs in the Lazio region.

At the Monte Mesole site, open shrublands 2–3 m high dominated by *Juniperus deltoides* are found (Suppl. material 2: fig. S6). These communities host only shrubby forms of *Ostrya carpinifolia* and *Quercus ilex* as other phanerophytes species occurring in the community. The

Juniperus deltoides shrublands are distributed within a matrix of dry grassland dominated by *Koeleria splendens* and *Bromopsis erecta* of the association *Violo pseudogracilis-Koelerietum splendentis*, which tends to form a vegetation mosaic together with micro-garrigue stands dominated by *Salvia officinalis* (*Elaeoselino asclepii-Salvietum officinalis*) (see Di Pietro 2011). At the 5210 site of Monte Le Festole, the *Juniperus deltoides* communities (Suppl. material 2: fig. S7) are structurally more complex, forming a wide coalescence of *Juniperus* individuals. In these communities, *Daphne sericea*, *Cistus creticus* subsp. *eriocephalus*, *Rhamnus saxatilis*, and *Rosa agrestis* are also frequent in the understory, together with shrubby forms of *Fraxinus ornus*, *Quercus ilex*, and *Q. pubescens*. At a wider scale, the *Juniperus deltoides* communities are arranged in a mosaic pattern with dry grasslands dominated by *Bromopsis erecta* and rich in micro-chamaephytes such as *Cytisus spinescens*, *Euphorbia spinosa*, *Helichrysum italicum*, *Teucrium montanum*, and *Lotus hirsutus* (*Helichryso italici-Brometum erecti* Di Pietro 2011). At both sites, especially at Monte Le Festole, habitat 5210 is severely threatened by the cutting or burning of shrub communities to create new pastures. Further explanation is needed to justify the assignment of the *Juniperus deltoides* communities of the Aurunci Mountains to habitat 5210. This is because *Juniperus deltoides* is not listed as a diagnostic species in either the European or Italian Interpretation Manuals, and the site lacks many of the additional diagnostic species listed in Biondi et al. (2009). The ecological and bioclimatic interpretation of habitat 5210 (Biondi et al. 2009) is much more restrictive than that in Manual EUR 28 (European Commission 2013). The former describes *Juniperus*-dominated communities as being mainly occurring in the thermo-Mediterranean belt, whereas the latter describes them as occurring in areas characterized by a Mediterranean to sub-Mediterranean climate. The occurrence of companion species belonging to the Mediterranean maquis, particularly from the thermo-Mediterranean bioclimatic zone, is addressed solely in the Italian Interpretation Manual. In the submontane belt of the Aurunci Mountains, this *Juniperus* matorral represents tall shrub patches in a mosaic matrix between grasslands-garrigues and woodlands. The shrub patches are completely dominated by *Juniperus deltoides* (evergreen), with the addition of woody phanerophytes such as *Quercus ilex* (evergreen sclerophyllous) and *Daphne sericea* (evergreen lauriphyllous). There is also a minimal contribution of thermophilous deciduous trees, such as *Ostrya carpinifolia* and *Quercus pubescens*. These species, together with *Quercus ilex*, represent the characteristic species of the surrounding potential forest vegetation. This situation is physiognomically and dynamically similar to that reported for some *Juniperus oxycedrus* communities of Tuscany growing on serpentine substrates (e.g., Monti Rognosi), which are also included in habitat 5210 (see Viciani et al. 2005; Lastrucci et al. 2009), as well as to the sub-mediterranean *Juniperus oxycedrus* s.l. communities of the Emilia-Romagna region (Bassi 2007).

Juniperus deltoides is currently described as a cryptic species morphologically difficult to distinguish from *Juniperus oxycedrus* (Adams 2014; Roma-Marzio et al. 2017; Lantushenko et al. 2023). Consequently, the precise distribution of the two species in the Italian Peninsula remains uncertain. The studies proposing the separation of *Juniperus oxycedrus* from *Juniperus deltoides* were published after the publication of the two Interpretation Manuals (European and Italian). Furthermore, given that the EUR28 manual only includes species belonging to the *Juniperus* genus in the diagnostic component for habitat 5210, it is highly probable that *Juniperus deltoides* should also be considered as an official diagnostic species of this habitat. Moreover, Biondi et al. (2009) indicate the binomial *Juniperus oxycedrus* s.l. as the diagnostic species for subtype 32.131, indirectly including other taxa such as *Juniperus oxycedrus* subsp. *macrocarpa*, now known as *Juniperus macrocarpa*, and presumably also *Juniperus deltoides*.

#161. Annex I Habitat: 6110* Rupicolous calcareous or basophilic grasslands of the *Alysso-Sedion albi* (Bonini F, Grassi A, Gigante D)

EUNIS Classification system: R13 – Cryptogam-and annual-dominated vegetation on calcareous and ultramafic rock outcrops (EEA 2021).
Biogeographical Region: Mediterranean.
National Habitat Checklist of reference: Italian Interpretation Manual of the Directive 92/43/EEC Habitats (Biondi et al. 2009).
Phytosociological reference: *Petrorhagio saxifragae-Sedetum sexangularis* Venanzoni et Gigante 1999, *Alysso alyssoidis-Sedion* Oberd. et T. Müller in T. Müller 1961, *Alysso-Sedetalia* Moravec 1967, *Sedo-Scleranthetea* Br.-Bl. 1955 (Mucina et al. 2016).
Geographic information: Italy, Umbria, Terni, Montecchio, ridge between Monte Croce di Serra and Monte Melezzole, 966 m a.s.l., Coordinates: 42.662117°N, 12.321477°E (Suppl. material 1: table S4, Rel. 1); 970 m a.s.l., Coordinates: 42.662261°N, 12.321702°E (Suppl. material 1: table S4, Rel. 2); Monte Melezzole, southern side, 972 m a.s.l., Coordinates: 42.663242°N, 12.321323°E (Suppl. material 1: table S4, Rel. 3).
Cell ID in the EEA reference grid: 10kmE451N217 (Suppl. material 2: fig. S8).
Natura 2000 Site Code: SAC IT5220008 "Monti Amerini".
Phytosociological table: Suppl. material 1: table S4; nomenclature and taxa delimitation according to Portal to the Flora of Italy (2026).
Notes: The surveyed vegetation consists of co-dominated stands of *Sedum sexangulare* and *Sedum album* on calcareous rocky outcrops at Monte Croce di Serra and Monte Melezzole, the highest peaks of the Amerini Mountains (Suppl. material 2: fig. S9). These communities are scattered in small patches within localized clearings that show evident signs of progressive shrub recolonization as a con-

sequence of the reduction in grazing pressure. The surrounding landscape is characterized by forests dominated by *Quercus ilex*, corresponding to habitat 9340 "*Quercus ilex* and *Quercus rotundifolia* forests".

#162. Annex I Habitat: 6220* Pseudo-steppe with grasses and annuals of the *Thero-Brachypodietea* (Perrino EV, La Rotonda P, Longo G)

EUNIS Classification system: R1F – Mediterranean annual-rich dry grassland (EEA 2021).
Biogeographical Region: Mediterranean.
National Habitat Checklist of reference: Italian Interpretation Manual of the Directive 92/43/EEC Habitats (Biondi et al. 2009).
Phytosociological reference: *Trachynion distachyae* Rivas-Mart. 1978, *Brachypodietalia distachyi* Rivas-Mart. 1978, *Stipo-Trachynietea distachyae* S. Brullo in S. Brullo et al. 2001 (Mucina et al. 2016).
Geographic information: Italy, Puglia, Bari, Conversano, near Monte Ferraro, 270 m a.s.l., Coordinates: 40.913924°N, 17.052998°E (Suppl. material 1: table S5, Rel. 1); *ibidem*, 265 m a.s.l., Coordinates: 40.913597°N, 17.053676°E (Suppl. material 1: table S5, Rel. 2).
Cell ID in the EEA reference grid: 10kmE491N200 (Suppl. material 2: fig. S10).
Natura 2000 Site Code: Currently not included in any Natura 2000 Site.
Phytosociological table: Suppl. material 1: table S5; nomenclature and taxa delimitation according to Portal to the Flora of Italy (2026).
Notes: The studied annual meadows are located in the hinterland of Conversano, a small town in the province of Bari, within an uncultivated area near a *Quercus trojana* wood (habitat 9250). According to the technical report (San Miguel 2008), the surveyed vegetation (Suppl. material 2: figs S11, S12) corresponds to the subtype 3 (*Brachypodietalia distachyi*) of Habitat 6220*, and transitions into perennial forms of the same habitat (subtype 1: *Lygeo-Stipetalia*) characterized by a high cover of *Dactylis hispanica*. Nowadays, the greatest threat for this habitat is the transformation into agricultural land, which has significantly reduced its extent in the surrounding areas. In fact, the transformation of these communities into arable land results in a rapid disappearance of biodiversity, whose recovery might require decades (Dutoit et al. 2005; Römermann et al. 2005).

#163. Annex I Habitat: 6510 Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*) (Preo SM, Favarin S, Masiero M)

EUNIS Classification system: R22 – Low and medium altitude hay meadows (EEA 2021).
Biogeographical Region: Continental.
National Habitat Checklist of reference: Italian Interpretation Manual of the Directive 92/43/EEC Habitats (Biondi et al. 2009).
Phytosociological reference: *Arrhenatherion elatioris* Koch 1926, *Arrhenatheretalia elatioris* Tx. 1931, *Molinio-Arrhenatheretea* Tx. 1937 (Mucina et al. 2016).
Geographic information: Italy, Veneto, Treviso, Vittorio Veneto, Confin, 128 m a.s.l., Coordinates: 45.945194°N, 12.261298°E (Suppl. material 1: table S6, Rel. 1); Italy, Veneto, Treviso, San Pietro di Feletto, Rua, 227 m a.s.l., Coordinates: 45.920817°N, 12.248399°E (Suppl. material 1: table S6, Rel. 2).
Cell ID in the EEA reference grid: 10kmE449N253 (Suppl. material 2: fig. S13).
Natura 2000 Site Code: Currently not included in any Natura 2000 Site.
Phytosociological table: Suppl. material 1: table S6; nomenclature and taxa delimitation according to Portal to the Flora of Italy (2026).
Notes: The surveyed sites correspond to semi-natural lowland mesic meadows located in the pre-alpine hilly sector of Treviso province, within the municipalities of Vittorio Veneto and San Pietro di Feletto. The sites lie within a highly intensive agricultural landscape dominated by vineyards, and they both cover a total area of approximately 4.2 ha. Management practices in these meadows include mowing and hay harvesting twice a year, in June and September. Despite the presence of some ruderal species with low cover (which nevertheless is a common feature of lowland meadows), the species composition clearly assigns these grasslands to the *Arrhenatherion elatioris* Koch 1926 alliance, as indicated by the high cover of *Arrhenatherum elatius*, the diagnostic species of this syntaxon. Across the two sites, *Arrhenatherum elatius* co-occurs with other characteristic species of habitat 6510, including *Trisetum flavescens*, *Plantago lanceolata*, *Salvia pratensis*, *Daucus carota*, *Leontodon hispidus*, and *Silene vulgaris* subsp. *vulgaris*. This meadow type has been extensively documented in North-Eastern Italy, with several studies providing appropriate syntaxonomic references for habitat 6510 (e.g., Poldini and Oriolo 1994; Buffa et al. 1995; Scotton et al. 2012; Tasinazzo 2014). Given the high suitability of the surrounding landscape for viticulture, the conservation of these two meadows (Suppl. material 2: figs S14, S15) is particularly important, as vineyard expansion has led to increasing fragmentation and loss of semi-natural grasslands in this area.

#164. Annex I Habitat: 6510 Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*) (Villani M, Marchesin M)

EUNIS Classification system: R22 – Low and medium altitude hay meadows (EEA 2021).

Biogeographical Region: Continental.
National Habitat Checklist of reference: Italian Interpretation Manual of the Directive 92/43/EEC Habitats (Biondi et al. 2009).
Phytosociological reference: *Arrhenatherion elatioris* Koch 1926, *Arrhenatheretalia elatioris* Tx. 1931, *Molinio-Arrhenatheretea* Tx. 1937 (Mucina et al. 2016).
Geographic information: Italy, Veneto, Verona, Grezzana, Le Volpare, 505 m a.s.l., Coordinates: 45.521526°N, 10.990663°E (Suppl. material 1: table S7, Rel. 1); *ibidem*, 517 m a.s.l., Coordinates: 45.523872°N, 10.990599°E (Suppl. material 1: table S7, Rel. 3); Italy, Veneto, Verona, Negrar, Montecchio, 467 m a.s.l., Coordinates: 45.520065°N, 10.979618°E (Suppl. material 1: table S7, Rel. 2); Italy, Veneto, Verona, Verona, Vajo Galina, 212 m a.s.l., Coordinates: 45.494187°N, 10.998327°E (Suppl. material 1: table S7, Rel. 4); *ibidem*, 220 m a.s.l., Coordinates: 45.495395°N, 10.999004°E (Suppl. material 1: table S7, Rel. 5); Italy, Veneto, Verona, Maso, 390 m a.s.l., Coordinates: 45.510086°N, 10.976211°E (Suppl. material 1: table S7, Rel. 6).
Cell ID in the EEA reference grid: 10kmE439N248 (Suppl. material 2: fig. S13); the cell refers to Suppl. material 1: table S7, Rels. 4–6.
Natura 2000 Site Code: SAC IT3210012 "Val Galina e Progno Borago".
Phytosociological table: Suppl. material 1: table S7; nomenclature and taxa delimitation according to Portal to the Flora of Italy (2026).
Notes: The semi-natural meadows belonging to the *Arrhenatherion* alliance found in lowland and hilly areas of North-Eastern Italy have been broadly investigated and related to the EU habitat 6510 (Poldini and Oriolo 1994; Buffa et al. 1995; Ziliotto et al. 2004; Tasinazzo 2009, 2014; Zanatta 2018).
At Val Galina and Progno Borago site, mesophilous hay meadows are not widespread. In fact, they occupy only 1.2% (7,7 ha) of the total area of the SAC, whereas the hilly landscape is mainly characterized by vineyards, olive groves, dry grasslands, and thermophilous deciduous forests. The sites are representative of regularly mowed and not intensively fertilized meadows (Suppl. material 2: figs S16, S17). These mesophilous hay meadows could be more widespread within the SAC; however, in some areas, intensive fertilization or overgrazing has disrupted their floristic and physiognomic structure.
The habitat occurrence within the SAC IT3210012 is not reported in the Standard Data Form, nor within the cell 10kmE439N248 in the 4th Habitat report ex-Art. 17 (period 2013–2018; Eionet 2019). EU habitat 6510 (Suppl. material 1: table S7, Rels. 4–6) is very localized within the cell. Moreover, this habitat was documented in the adjacent cell 10kmE439N249 (where it had been previously recorded), both within SAC IT3210012 (Suppl. material 1: table S7, Rels. 1–2) and in neighbouring stands outside the SAC (Suppl. material 1: table S7, Rel. 3). These latter records are significant for proposing an expansion of the SAC.

#165. Annex I Habitat: 7220* Petrifying springs with tufa formation (*Cratoneurion*) (Patera G)

EUNIS Classification system: C2.121 – Petrifying springs with tufa or travertine formations (EEA 2019).
Biogeographical Region: Continental.
National Habitat Checklist of reference: Italian Interpretation Manual of the Directive 92/43/EEC Habitats (Biondi et al. 2009).
Phytosociological reference: *Eucladium verticillatum* community, *Cratoneurion commutati* W. Koch 1928, *Montio-Cardaminetalia* Pawl. 1928, *Montio-Cardaminetea* Br.-Bl. and Tx ex Klika and Had. 1944 (Mucina et al. 2016).
Geographic information: Italy, Lombardy, Brescia, Corte Franca, 210 m a.s.l., Coordinates: 45.609807°N, 10.019669°E (Suppl. material 1: table S8, Rel. 1); *ibidem*, 209 m a.s.l., Coordinates: 45.609404°N, 10.020477°E (Suppl. material 1: table S8, Rel. 2).
Cell ID in the EEA reference grid: 10kmE432N249 (Suppl. material 2: fig. S18).
Natura 2000 Site Code: Currently not included in any Natura 2000 Site.
Phytosociological table: Suppl. material 1: table S8; nomenclature and taxa delimitation according to Portal to the Flora of Italy (2026), for bryophytes with Aleffi et al. (2023).
Notes: The community, extensively dominated by *Eucladium verticillatum* (Suppl. material 2: fig. S19), develops within a system of calcareous springs along a slope, characterized by laminar water flow and active carbonate tufa deposition.
Communities dominated by *Eucladium verticillatum* have been notably attributed to the alliance *Adiantion* (Zechmeister and Mucina 1994); however, the species is widely regarded as diagnostic of petrifying spring habitat 7220*, which is usually assigned to the alliance *Cratoneurion commutati*, even in the absence of *Palustriella commutata* (Couvreur et al. 2016; Hugonnot et al. 2017).
The occurrence of this habitat in a lowland context within the Franciacorta area, subject to strong viticultural pressure, together with the presence of a rare low-altitude population of *Schoenus nigricans*, further increases the conservation significance of the site.

#166. Annex I Habitat: 8230 Siliceous rock with pioneer vegetation of the *Sedo-Scleranthion* or of the *Sedo albi-Veronicion dillenii* (Lonati M, Mainetti A, Pittarello M)

EUNIS Classification system: R12 – Cryptogam- and annual-dominated vegetation on siliceous rock outcrops (EEA 2021).
Biogeographical Region: Alpine.
National Habitat Checklist of reference: Italian Interpretation Manual of the Directive 92/43/EEC Habitats (Biondi et al. 2009).

Phytosociological reference: *Sedo-Scleranthion* Br.-Bl. et Richard 1950, *Sedo-Scleranthetalia* Br.-Bl. 1955, *Sedo-Scleranthetea* Br.-Bl. 1955 (Mucina et al. 2016).
Geographic information: Italy, Piedmont, Torino, Pont Canavese, Nivoiaje di sopra, 1377 m a.s.l, Coordinates: 45.441301°N, 7.566320°E (Suppl. material 1: table S9, Rel. 1).
Cell ID in the EEA reference grid: 10kmE413N248 (Suppl. material 2: fig. S20).
Natura 2000 Site Code: Currently not included in any Natura 2000 Site.
Phytosociological table: Suppl. material 1: table S9; nomenclature and taxa delimitation according to Portal to the Flora of Italy (2026).
Notes: Habitat 8230 is quite frequent in the Alpine biogeographical region and in the Western Alps, typically found in superficial soils of siliceous rock surfaces.
In the investigated area, the habitat is confined to small rocky microsites, such as on boulders characterized by the accumulation of a thin edaphic layer only a few centimetres deep (Suppl. material 2: fig. S21). Vegetation establishment under such conditions is facilitated by the high precipitation regime (up to 1800 mm yr^{-1}), which allows the coexistence of numerous ingressive species typical of the surrounding pastures. The peculiar edaphic constraints strongly limit the pedogenic potential toward the development of deeper soils, which could otherwise support either acidophilous grasslands or chamaephytic communities.

#167. Annex I Habitat: 91M0 Pannonian-Balkanic turkey oak–sessile oak forests (Gianguzzi L, Rigoglioso A, Caldarella O)

EUNIS Classification system: T19 – Temperate and submediterranean thermophilous deciduous forest (EEA 2021).
Biogeographical Region: Mediterranean.
National Habitat Checklist of reference: Italian Interpretation Manual of the Directive 92/43/EEC Habitats (Biondi et al. 2009).
Phytosociological reference: *Quercetum gussonei* Brullo et Marcenò 1985, *Quercenion dalechampii* Brullo 1984, *Erico arboreae-Quercion ilicis* Brullo, Di Martino et Marcenò 1977, *Quercetalia ilicis* Br.-Bl. ex Molinier 1934, *Quercetea ilicis* Br.-Bl. ex A. et O. Bolòs 1950 (Brullo et al. 2009; Terzi et al. 2020).
Geographic information: Italy, Sicily, "Bosco della Ficuzza, Rocca Busambra, Bosco del Cappelliere e Gorgo del Drago" Nature Reserve, various localities (Tab. 16 in Brullo and Marcenò 1985); Italy, Sicily, Palermo, Godrano, "Bosco della Ficuzza, Rocca Busambra, Bosco del Cappelliere e Gorgo del Drago" Nature Reserve, Contrada S. Barbara, 750 m a.s.l., Coordinates: 37.888245°N, 13.399131°E (Suppl. material 1: table S10, Rel. 1); Italy, Sicily, Palermo, Monreale, "Bosco della Ficuzza, Rocca Busambra, Bosco del Cappelliere e Gorgo del Drago" Nature Reserve, Piano Torre, 957 m a.s.l., Coordinates: 37.908633°N, 13.405833°E (Suppl. material 1: table S10, Rel. 2); *ibidem*, 954 m a.s.l., Coordinates: 37.908729°N, 13.405974°E (Suppl. material 1: table S10, Rel. 3); *ibidem*, 955 m a.s.l., Coordinates: 37.908657°N, 13.406262°E (Suppl. material 1: table S10, Rel. 4); *ibidem*, 940 m a.s.l., Coordinates: 37.908982°N, 13.406164°E (Suppl. material 1: table S10, Rel. 5).
Cell ID in the EEA reference grid: 10kmE462N165 (Suppl. material 2: fig. S22).
Natura 2000 Site Code: SAC ITA020007 "Boschi Ficuzza e Cappelliere, Vallone Cerasa, Castagneti Mezzojuso"; SPA ITA020048 "Monti Sicani, Rocca Busambra e Bosco della Ficuzza".
Phytosociological table: Suppl. material 1: table S10; nomenclature and taxa delimitation according to Portal to the Flora of Italy (2026), aside from *Quercus gussonei*, for which we referred to Brullo and Brullo (2020).
Notes: In Sicily, *Quercus gussonei* (synonym of *Quercus cerris* var. *gussonei*, *Quercus pseudosuber* var. *gussonei*, and *Quercus haliphleos*) is included within the *Quercus cerris* group. This taxon is considered endemic to the island, and is the communities it forms are all ascribed to the *Quercetum gussonei* association (Brullo and Marcenò 1985; Brullo et al. 2009). These forests are widespread in the Nebrodi Mountains – between (400) 700 and 1000 m a.s.l. (Gianguzzi 2007; Gianguzzi et al. 2016) – and in another isolated area in the province of Palermo, within the "Boschi di Ficuzza e Rocca Busambra" Nature Reserve (Brullo and Brullo 2020; Gianguzzi 1999).
In the Nebrodi Mountains, these woods are attributed to habitat 91M0 – together with the more typical *Quercus cerris* s.s. forests, at higher elevations, belonging to the association *Arrhenathero nebrodensis-Quercetum cerridis* Brullo C. et al., 2012 – differently from those of the "Bosco della Ficuzza, Rocca Busambra, Bosco del Cappelliere e Gorgo del Drago" Nature Reserve (Brullo and Brullo 2020; Gianguzzi 1999), which are the subject of these records.
In this area, *Quercus gussonei* communities extend for about 387 ha, all of them included in a single cell ID of the EEA reference grid (10kmE462N165), forming two almost contiguous nuclei: i) the first (about 234 ha) covers the ridges of Torre del Bosco and Cozzo Bileo (in the municipalities of Monreale and, marginally, Marineo and Godrano), between 650 and 990 m a.s.l. (Suppl. material 2: fig. S23); ii) the second (about 153 ha) extends between the localities of Santa Barbara, Lupotto, Portella Gramigna, and Pulpito del Re (municipalities of Marineo and Godrano), between 550 and 861 m a.s.l.
These communities constitute intact woodlands, occasionally interrupted by anthropogenic patches of *Pinus* spp., occurring on sandstone substrates and sandy soils of varying depth within the upper sub–humid meso–Mediterranean bioclimatic belt (Gianguzzi 1999).
In the Annex I Habitat Types of Directive 92/43/EEC, *Quercus gussonei* communities were erroneously attributed to 91AA* (Eastern white oak woods), grouped with *Quercus pubescens* s.l. (sub *Quercus leptobalanos*) and ascribed to the association *Quercetum leptobalani* Brullo 1984. However, these are distinct formations, which

should instead be attributed to habitat 91M0, as reported for the Nebrodi Mountains (e.g., see the Natura 2000 Standard Data Form of SAC ITA030018 (EEA 2024)).

Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

Artificial Intelligence (AI) use

The authors accept full responsibility for the content of the manuscript, including the disclosure of any use of AI.
No AI tools were used in the preparation of this manuscript.

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Author contributions

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Data availability

All of the data that support the findings of this study are available in the main text or Supplementary Information.

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Supplementary material 1

Phytosociological relevés

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Data type: xlsx

Explanation note: **table S1:** Habitat 3220 – NHR#158; **table S2:** Habitat 3270 – NHR#159; **table S3:** Habitat 5210 – NHR#160; **table S4:** Habitat 6110* – NHR#161; **table S5:** Habitat 6220* – NHR#162; **table S6:** Habitat 6510 – NHR#163; **table S7:** Habitat 6510 – NHR#164; **table S8:** Habitat 7220* – NHR#165; **table S9:** Habitat 8230 – NHR#166; **table S10:** Habitat 91M0 – NHR#167.

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Supplementary material 2

Maps and photos

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