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Abstract (300 words max.)

- *Questions* Can we reconcile regional and European classifications of anthropogenic plant communities at the biogeographical scale? How are these communities characterized by species origins, traits and ecological preferences?
- *Location* Atlantic territories in the NW Iberian Peninsula (a.k.a. Cantabrian Mixed Forests ecoregion); south-western Europe.
- *Methods* We classified 2,508 plots with the aim of being consistent with regional phytosociological expertise, while matching that expertise with current EuroVegChecklist alliances. We used modified TWINSPAN to revise the original phytosociological classification, followed by semi-supervised re-classification of the whole dataset. We determined the proportion of natives, archaeophytes and neophytes. We also described the alliances in terms of species traits (lifeforms, height and flowering phenology) and ecological requirements (temperature, moisture, light, nutrients, soil reaction, disturbance frequency and severity).
- *Results* We assigned 2,086 vegetation plots to 25 anthropogenic alliances representing 9 vegetation classes (*Cymbalario-Parietarietea diffusae*, *Polygono-Poetea annuae*, *Papaveretea rhoeadis*, *Digitario sanguinalis-Eragrostietea minoris*,

Chenopodietea, *Sisymbrietea*, *Bidentetea*, *Artemisietea vulgaris* and *Epilobietea angustifolii*). The plots included 1,149 taxa: 78% natives, 15% archaeophytes and 7% neophytes. Vegetation groups were organized along a principal axis of abiotic stress (dry-sunny to moist-shady habitats) and a secondary axis of disturbance.

- *Conclusions* In the Iberian Atlantic territories, anthropogenic habitats host one third of the regional plant species pool and one fifth of the Iberian flora. Mesic perennial ruderal vegetation is especially rich in native species and can be a biodiversity asset in urban landscapes. Our biogeographical-level synthesis can improve the management of anthropogenic plant communities and contribute towards a European-level synthesis of human-made vegetation.

Keywords (10 max)

Synanthropic vegetation, manmade habitats, human-made habitats, urban biodiversity, neophytes, archaeophytes, alien plants, habitat classification, semi-supervised classification, Cantabrian Mixed Forests

Introduction

Anthropogenic vegetation is the sum of plant communities assembled as a direct consequence of human activities. In general, this vegetation is composed of the so-called weeds of arable fields and the ruderal plants growing on human settlements and nearby habitats (Lososová & Simonova 2008). In densely populated landscapes, the anthropogenic communities that colonize vacant lots (Johnson et al. 2017) are a useful natural resource with high ecological and societal potential (Anderson & Minor 2017; Kowarik 2018). Anthropogenic vegetation can also mitigate regional-level extreme climatic events (Stefanon et al. 2014). Furthermore, many synanthropic plants are adapted to disturbance and can accumulate heavy metals in their biomass (Kostryukova et al. 2017), making them valuable candidates for nature-based solutions such as bioremediation and restoration of degraded post-industrial landscapes (Song et al. 2019).

In temperate Europe, anthropogenic vegetation is a melting pot of floras from different biogeographical origins. The starting native pool of species favored by humans has been constantly enriched by human-assisted arrival of alien (i.e. non-native) species (Pokorná et al. 2018). The introduction of archaeophytes (i.e. alien species arriving before 1.500 CE) likely started in the early Neolithic and peaked in the Bronze Age, with successive waves during periods of accelerated human colonization such as the early Middle Ages (Pokorná et al. 2018). In Europe, synanthropic archaeophytes include many Mediterranean taxa originating from the segetal flora of the Near East (Zohary 1950). Some of these archaeophytes are 'obligate weeds' that do not occur in non-anthropogenic habitats and are assumed to have evolved together with human agriculture (Zohary 1950). The synanthropic flora of Europe has been further enriched by neophytes, alien taxa that arrived after the expansion of intercontinental trade in the Modern Age (after 1.500 CE) (Brun 2009). Synanthropic neophytes therefore include many American, African and Asian taxa that arrived in Europe because of the global trade networks established by western European colonialism (Lenzner et al. 2022). In the last century, the European anthropogenic vegetation has shown a decrease in species richness and diversity (Pyšek et al. 2004), as rare synanthropic species have become rarer and neophytes have increased their abundance at the expense of natives and archaeophytes (Lososová & Simonova 2008).

Despite the potential of anthropogenic vegetation as a biodiversity asset in human-made landscapes and its ecological interest as an assemblage of species pools from different biogeographical origins, human-made vegetation is largely absent from ecosystem management. A comprehensive management will require a solid definition, classification and description of anthropogenic plant communities. However, the classification of anthropogenic vegetation is subject to particularities making it a special case compared to the classification of non-anthropogenic communities. In human-made habitats, the traditional understanding of community assembly based on sequential filtering (dispersal, abiotic and biotic) must incorporate an additional filtering based on human preferences and actions (Swan et al. 2021). Human landscapes are a mosaic of land uses (Pauleit & Breuste 2011), having specific effects on plant community assembly and driven by sociological rather than traditional ecological factors (Johnson et al. 2017). Another issue is defining anthropogenic vegetation, especially in a continent such as Europe where human impact on the landscape has been widespread since ancient times. The two major vegetation/habitat classifications coexisting in Europe today, phytosociological classification (Mucina et al. 2016) and the EUNIS habitat classification (Chytrý et al. 2020), have not fully equivalent definitions of which plant communities fall within their 'anthropogenic' or 'manmade' categories. These issues are further muddled by the fact that most classification studies of anthropogenic vegetation have focused either on a restricted political unit (Nemec et al. 2011; Tabasevic, Jovanovic, et al. 2021) or in a subset of the vegetation, such as segetal (Zohary 1950), ruderal

(Zaliberova 1995) or trampled (Golovanov et al. 2023) vegetation. There is a need for a numerical classification and synthesis of the full spectrum of anthropogenic vegetation, focusing on coherent biogeographical units, i.e. areas with a similar bioclimate, a shared biogeographic history and recurrent local ecosystems (Bailey 2004).

The Atlantic territories in the NW Iberian Peninsula (a.k.a. Cantabrian Mixed Forests ecoregion) have a long history of human habitation dating back to the Cantabrian Upper Paleolithic (Straus 2005). This, together with their transitional position at the border between the temperate and Mediterranean climatic zones of Europe, suggests a long regional history for archaeophyte-rich anthropogenic plant communities, supporting the current diverse anthropogenic vegetation with both temperate and Mediterranean floristic elements (Díaz González 2020). Moreover, historical trade links with America and Asia, together with the warm and humid temperate climate, have made the region a hotspot for biological invasions (Fernández de Castro et al. 2018; Lázaro-Lobo et al. 2024). Recent post-industrial land-use changes have left large areas with abandoned industrial sites (i.e. brownfields) whose management and restoration requires an understanding of the anthropogenic communities able to colonize them (Gallego et al. 2016; Matanzas et al. 2021). Although there is a long tradition of studying weed and ruderal communities within the area (Aedo et al. 1988; Díaz González et al. 1988; Loidi & Navarro Aranda 1988; Penas, Díaz González, García González, et al. 1988; Penas, Díaz González, Pérez Morales, et al. 1988; Loidi et al. 1995; Loidi et al. 1996) there is a current need for a biogeographical-level synthesis that revises and updates the classification in accord with recent developments in European vegetation science (Mucina et al. 2016) and habitat classification (Chytrý et al. 2020). In this article, we have performed such a synthesis with the following two objectives: (1) to provide an updated classification at the alliance level of anthropogenic plant communities in the Iberian Atlantic territories; and (2) to characterize the diversity of anthropogenic vegetation in terms of species pools (natives, archaeophytes, neophytes); species traits (life form, plant height, flowering phenology); and ecological requirements (temperature, moisture, light, nutrients, soil reaction, disturbance frequency and disturbance severity).

Methods

Data curation and taxonomic criteria

We performed all data management and analysis with R version 4.3.1 (R Core Team 2023), using the R package *tidyverse* (Wickham et al. 2019) for data processing and visualization. We homogenized all taxon names using Euro+Med (Euro+Med 2006) or Plants of the World Online (POWO 2023) for taxa not in Euro+Med. For the nomenclature of syntaxa, we followed Mucina *et al.* (2016) for alliances and higher ranks and Rivas-Martínez *et al.* (2001) for associations. The original datasets, as well as R code for analysis and creation of the manuscript, are stored in a GitHub repository available at Zenodo (see 'Data availability statement').

Biogeographical territory under study

We studied the anthropogenic plant communities of the Iberian Atlantic territories, a biogeographical unit defined by Fernández Prieto *et al.* (2020; 2023) as the territories with a temperate climate in the north-western part of the Iberian Peninsula (NW Portugal, N Spain, SW France). Our study area follows the detailed borders provided by Fernández Prieto *et al.* (2020; 2023) and is broadly equivalent to the Cantabrian Mixed Forests ecoregion *sensu* Olson *et al.* (2001), to the Iberian part of the European Atlantic province *sensu* Rivas-Martínez *et al.* (2014; 2017) (i.e. the Orocantabrian subprovince and parts of the Cantabro Atlantic subprovince) and to the Iberian section of the Atlantic biogeographical region of the European Environmental Agency (https://www.eea.europa.eu/data-and-maps/figures/biogeographical-regions-in-europe-2).

Definition of anthropogenic vegetation

To circumscribe our study vegetation, we followed the definition of anthropogenic vegetation in the revised classification of the vegetation of Europe by Mucina *et al.* (2016). In our study area, this potentially includes the vegetation classes *Polygono-Poetea annuae*, *Papaveretea rhoeadis*, *Digitario sanguinalis-Eragrostietea minoris*, *Chenopodietea*, *Sisymbrietea*, *Bidentetea*, *Artemisietea vulgaris* and *Epilobietea angustifolii*. For the sake of completeness, we also considered the class *Cymbalario-Parietarietea diffusae* included by Mucina *et al.* (2016) in the vegetation of rock crevices and screes, since this class encompasses the vegetation of human-made walls.

Checklist of anthropogenic syntaxa

To assist in our classification, we prepared a checklist of anthropogenic syntaxa that could be present in our study area (**Appendix S1**), based on regional syntaxonomical checklists (Izco et al. 2000; Díaz González 2020; Durán Gómez 2020) and recent revisions at the European level (Mucina et al. 2016; Preislerová et al. 2022). This syntaxonomical checklist included 34 anthropogenic vegetation alliances that could be present in the Iberian Atlantic territories according to the literature.

Vegetation data selection

We retrieved Iberian Atlantic anthropogenic vegetation plots from the Iberian and Macaronesian Vegetation Information System (SIVIM) (Font et al. 2012). To identify plots as anthropogenic, we selected those plots that had been assigned by the original authors of the plot into any anthropogenic syntaxa in our syntaxonomical checklist. However, since not all plots in SIVIM have an assigned syntaxon, we also retrieved additional plots using the expert system created by Chytrý *et al.* (2020) to classify vegetation plots into EUNIS pan-European habitat types. We retrieved plots that had been assigned to any habitat related to the anthropogenic vegetation classes we had previously defined: all habitats in the level 1 code *V Vegetated man-made habitats*, plus level 3 codes *R55 Lowland moist or wet tall-herb and fern fringe* and *R57 Herbaceous forest clearing vegetation*. It must be noted that habitats *R55* and *R57* include communities that are classified as *R Grasslands and lands dominated by forbs, mosses or lichens* by EUNIS but as *Anthropogenic vegetation* by Mucina *et al.* (2016). The extraction of data from SIVIM produced an initial pool of 3,160 vegetation plots, to which we added 89 vegetation plots of urban or peri-urban plant communities sampled by us or extracted from local literature not included in SIVIM (Zabaleta Mendizábal 1990; Uría Arizaga 2020).

Vegetation data cleaning

We performed an exploratory data analysis of these 3,249 plots using modified Two-Way Indicator Species Analysis (TWINSPAN) (Roleček et al. 2009) with the R package *twinspanR* (Zelený 2021). We used 3 pseudospecies cut levels (0, 15, 25), a minimum group size of 10 plots and Sørensen's average dissimilarity. During this analysis we identified 741 outlier plots which did not belong to either the target anthropogenic vegetation or to the geographical area of the Iberian Atlantic territories. The majority of these plots corresponded to coastal plant communities and had been misclassified by the expert system. We removed these plots, resulting in a dataset of 2,508 vegetation plots for data analysis: 2,419 plots from SIVIM, originally recorded in 89 publications (**Appendix S2**); plus 89 plots added by us.

Training dataset for semi-supervised classification and validation of alliances

The main aim of our classification was for it to be consistent with regional phytosociological expertise and to match that expertise with current EuroVegChecklist alliances (Mucina et al. 2016). To achieve this, one advantage of using the SIVIM database is that a majority of the plots had been assigned to associations or alliances by the original authors (Font et al. 2012). However, there could be misclassification due to unclear concepts or human error. Therefore, we used TWINSPAN to revise the classification by the original authors, to define the number of clusters that better aligned with our syntaxonomical checklist and to remove outliers or misclassified plots.

We started this stage of the analyses by keeping only those plots (n = 2,095) that had been assigned by the original authors of the plot to any of the 9 anthropogenic vegetation classes defined in our syntaxonomical checklist (i.e., we removed the plots without syntaxa, that had been retrieved solely by the expert system). Then, we performed a TWINSPAN classification (with the same settings as above) within each vegetation class, attempting to classify its plots into a number of clusters equal to the number of alliances of that class in our checklist. We assigned the resulting clusters to an alliance in our checklist based on their composition of diagnostic species as described in the regional literature. In some cases, this resulted in a classification into a number of clusters in which (1) more than one cluster was assigned to the same alliance in the checklist; and (2) some alliances in the checklist could not be assigned to any of the clusters (i.e. the plots that had been assigned by the original authors to that alliance were separated in different clusters). By the end of this process, of the 34 alliances in our checklist, 25 had been assigned to clusters. Nine alliances were not assigned to any cluster. Of these, eight had been assigned to a few plots by the original authors: *Onopordion castellani* (n = 6 plots), *Onopordion acanthii* (5), *Euphorbion prostratae* (4), *Caucalidion lappulae* (4), *Roemerion hybridae* (2), *Hordeion murini* (2), *Taeniathero-Aegilopion geniculatae* (1) and *Fragarion vescae* (1). The alliance *Aegopodion podagrariae* had been assigned by the original authors to 39 plots, but our TWINSPAN analysis could not separate this alliance from the alliances *Geo urbani-Alliarion officinalis* and *Balloto-Conion maculati*.

This stage of the analyses allowed us to identify those plots in which there was an agreement between (1) our TWINSPAN-based classification (i.e. numerical classification) and (2) the classification based on the original author's syntaxon (i.e. regional phytosociological expertise). These plots (n = 1,850) were the best representatives of each alliance and became our training dataset for semi-supervised classification.

Semi-supervised classification

Next, we conducted a semi-supervised classification (Tichý et al. 2014) of the whole dataset (n = 2,508 plots) into the 25 TWINSPAN-validated anthropogenic alliances. Semi-supervised classification uses a training subset of *a priori* classified vegetation plots to classify a secondary subset of unclassified plots (De Cáceres et al. 2010). Since our goal was to refine the classification of the whole dataset, we allowed plots from the training subset to be re-assigned to other alliances during the re-classification. In addition, semi-supervised classification can create new groups to place data points that do not match the already existing *a priori* groups, but attempts to do so resulted in new groups with no ecological significance and thus we kept the 25 alliances as final anthropogenic vegetation groups. Furthermore, we applied a noise clustering fuzzy algorithm, which allows plots to be classified either into the *a priori* alliances or into a *noise* group which includes outliers and transitional plots (Wiser & De Cáceres 2013). We set the fuzziness coefficient to a low value (m = 1) to accommodate a high number of transitional plots; and we set the distance to the noise class to d = 1. We performed this analysis with the R package *vegclust* (De Cáceres et al. 2010). The semi-supervised classification with noise clustering resulted in the final classification of 2,086 plots into 26 alliances and 422 plots left out in the noise group. We used pairwise PERMANOVA (with 100,000 iterations, Euclidean distances and Holm's p-value correction) fitted with the R package *RVAideMemoire* (Herve 2023) to test the significance of the final vegetation alliances; along with Principal Component Analysis (PCA) as implemented in the R package *FactoMineR* (Lê et al. 2008) to visualize the relationships between the classes and alliances.

Characteristic species and EUNIS habitat correspondence

To facilitate the use of the classification by local managers and environmental consultants, we calculated sets of characteristic species (Chytrý et al. 2020) for each one of the final 25 vegetation alliances. We defined dominant species as species with more than 25% cover in at least 5% of the vegetation plots of the group; constant species as species with a frequency higher than 50% in the group; and diagnostic species as species whose *IndVal* had a p-value lower than 0.05, as calculated with the R package *labdsv* (Roberts 2016) using 1.000.000 iterations. Additionally, we assigned to each alliance a regionalized level 4 EUNIS habitat code (https://eunis.eea.europa.eu/habitats-code-browser-revised.jsp).

Species origin as native, archaeophyte or neophyte

We classified the species as native, archaeophytes or neophytes in the Iberian Atlantic territories using the information in *Flora iberica* (1987-2020) and catalogues of archaeophytes for Britain (Preston et al. 2004) and the Czech Republic (Chytrý et al. 2021). We must stress that identifying archaeophytes in southern Europe is highly problematic (Celesti-Grapow et al. 2009) and our classification must be taken as an indication of putative archaeophyte character for the purposes of vegetation description and comparison with other European regions, rather than a definitive classification of the species; as stated by Preston *et al.* (Preston et al. 2004), the classification of a species as an archaeophyte should be interpreted as a hypothesis to be tested by further studies.

Species life form

Using *FloraVeg.EU* (2023) we extracted the species' life forms and kept *therophyte* and *geophyte* for further analysis since these two categories had the largest contribution to variance among alliances, as per an exploratory Principal Component Analysis (PCA) performed using the R package *FactoMineR* (Lê et al. 2008).

Species height and flowering phenology

From *Flora iberica* (1987-2020) we extracted the maximum height, median month of flowering and length of the flowering period of each species in the dataset. We used these variables to calculate plot-level community-weighted means (weighting by species cover) for each trait, to characterize the vegetation height and flowering phenology of the anthropogenic plant communities.

Species ecological indicator values

For each species in the dataset, we collected its ecological indicator values of temperature, moisture, light, nutrients and soil reaction (Dengler et al. 2023); and its disturbance frequency and severity indicator values (Midolo et al. 2023). To those species lacking an indicator value in the accessed references, we assigned a value by reciprocal averaging, i.e. by (1) calculating weighted average values of the species with values for each plot (weighting by species cover) and (2) assigning to the missing species the weighted average values of the plots where they were present (weighting by species cover). Then, for each vegetation plot, we calculated the plot-level mean of each indicator value.

Results

Overview of the classification

The semi-supervised classification resulted in the classification of 2,086 vegetation plots into 25 anthropogenic alliances (**Fig. 1**, description of the alliances and correspondence with EUNIS habitat types in **Appendix S3**, groups of characteristic species in **Appendix S4**, synoptic table in **Appendix S5**) representing 9 vegetation classes. The regional literature included in our dataset recognized 69 associations (**Appendix S6**) within these alliances, but exploratory analysis (not shown) indicated that the separation of these associations within the alliances had a generally weak support based on numerical classification methods.

The classified plots included 1,149 taxa or taxa aggregates. The 10 most frequent species were *Ochlopoa annua* (625 occurrences), *Urtica dioica* (588), *Sonchus oleraceus* (548), *Stellaria media* (520), *Capsella bursa-pastoris* (396), *Polygonum aviculare* (373), *Dactylis glomerata* (369), *Senecio vulgaris* (336) and *Anisantha sterilis* (310). Considering only those plots with the most frequent plot size range (10-30 m^2, n = 867 plots), the average species richness per plot was 16 (minimum = 3, maximum = 48). The class with the richest species pool was *Epilobietea angustifolii* (n = 605) and the poorest was *Bidentetea* (n = 132).

PCA ordination of the floristic composition (**Fig. 2A**) differentiated three vegetation groups: (1) trampled vegetation of class *Polygono-Poetea annuae*; (2) crop weeds of classes *Papaveretea rhoeadis* and *Digitario sanguinalis-Eragrostietea minoris*; and (3) perennial ruderal vegetation of classes *Artemisietea vulgaris* and *Epilobietea angustifolii*. The central position of the floristic space, between these three major groups, was occupied by the annual ruderal vegetation of classes *Chenopodietea*, *Sisymbrietea* and *Bidentetea*; as well as by the wall vegetation of class *Cymbalario-Parietarietea diffusae*. Separate PCAs within the major vegetation groups indicated a coherent separation between most of the alliances, but with some cases of relatively high overlap, especially between *Galio valantiae-Parietarion judaicae* and *Cymbalario-Asplenion*.

Proportion of natives, archaeophytes and neophytes

The total synanthropic species pool (n = 1,149) was composed of 78% natives (n = 899), 15% putative archaeophytes (n = 174) and 7% neophytes (n = 76). The most frequent putative archaeophytes were *Capsella bursa-pastoris* (396 occurrences), *Senecio vulgaris* (336), *Anisantha sterilis* (310), *Hordeum murinum* (297), *Anthemis arvensis* (290), *Raphanus raphanistrum* (236), *Vicia sativa* (229), *Malva sylvestris* (210), *Sisymbrium officinale* (185) and *Anisantha diandra* (175); while the most frequent neophytes were *Veronica persica* (215), *Erigeron canadensis* (136), *Amaranthus hybridus* (75), *Oxalis corniculata* (66), *Lepidium didymum* (59), *Oxalis latifolia* (56), *Paspalum distichum* (42), *Bidens frondosus* (34), *Cyperus eragrostis* (34) and *Symphyotrichum squamatum* (34).

By vegetation class, *Epilobietea angustifolii* had the highest proportion of natives in its species pool (82%); *Sisymbrietea* had the highest proportion of putative archaeophytes (30%); and *Bidentetea* had the highest proportion of neophytes (16%). The alliances with the highest proportions of archaeophytes in their species pools were *Chenopodion muralis* (35%%), *Silybo mariani-Urticion piluliferae* (31%) and *Sisymbrion officinalis* (30%); while the alliances with the highest proportion of neophytes were *Bidention tripartitae* (20%), *Allion triquetri* (12%) and *Spergulo arvensis-Erodion cicutariae* (11%).

At the community level, focusing on plot average proportions (**Fig. 3**), the alliances with the most archaeophytes were *Sisymbrion officinalis*, *Silybo mariani-Urticion piluliferae* and

Spergulo arvensis-Erodion cicutariae, in which only about half of the plot-level proportion was made up of native species. The alliances with the highest plot-level proportion of neophytes were *Bidention tripartitae*, *Paspalo-Agrostion semiverticillati* and *Spergulo arvensis-Erodion cicutariae*. Some alliances had high proportions of native species, e.g. *Epilobion angustifolii*, *Linario polygalifoliae-Vulpion alopecuri* and *Arction lappae*.

Community-level traits

The most frequent life form in the species pool (n = 1,149 species) were hemicryptophytes (44%), followed by therophytes (41%), geophytes (8%), chamaephytes (6%), phanerophytes (5%), bryophytes (1%) and hydrophytes (1%). The proportion of therophytes across classes and alliances (**Fig. 4**) agreed with the traditional description of the syntaxa: therophytes dominated the annual communities of trampled-soil vegetation (*Polygono-Poetea annuae*), crops weeds (*Papaveretea rhoeadis*, *Digitario sanguinalis-Eragrostietea minoris*) and annual ruderals (*Chenopodietea*, *Sisymbrietea*, *Bidentetea*); while perennial life forms (especially hemicryptophytes) dominated walls (*Cymbalario-Parietarietea diffusae*) and perennial ruderal vegetation (*Artemisietea vulgaris*, *Epilobietea angustifolii*). Geophytes represented a relatively high proportion of the vegetation in two alliances: *Allion triquetri* and *Senecionion fluviatilis*.

Community-weighted means for plant height (**Fig. 5A**) also agreed with the expected description of the syntaxa: the shortest communities were the dwarf-herb vegetation of trampled sites (*Polygono-Poetea annuae*, average height = 45.2 cm) and crop weeds (*Papaveretea rhoeadis*, 55.6 cm), while the tallest were the perennial ruderal vegetation of dry (*Artemisietea vulgaris*, 131 cm) and mesic (*Epilobietea angustifolii*, 138 cm) sites. The median month of flowering (**Fig. 5B**) corresponded to May (*Sisymbrietea*, *Chenopodietea*, *Papaveretea rhoeadis*), June (*Cymbalario-Parietarietea diffusae*, *Polygono-Poetea annuae*, *Epilobietea angustifolii*, *Artemisietea vulgaris*) or July (*Digitario sanguinalis-Eragrostietea minoris*, *Bidentetea*). The length of the flowering season (**Fig. 5C**) was generally high, from 5 months (*Artemisietea vulgaris*, *Epilobietea angustifolii*) to 6 (*Chenopodietea*, *Sisymbrietea*), 7 (*Bidentetea*, *Digitario sanguinalis-Eragrostietea minoris*, *Papaveretea rhoeadis*), 8 (*Polygono-Poetea annuae*) or 9 (*Cymbalario-Parietarietea diffusae*).

Community-level ecological preferences

To visualize the major patterns of variation in the ecological and disturbance preferences of the different anthropogenic communities (**Fig. 6**) we performed a PCA ordination of plot-level means (**Fig. 7**). The first two PCA axes explained 59% of the variance. The major contributors to axis 1 (36% variance explained) were light, nutrient and moisture requirements; it separated communities of open, dry and comparatively nutrient-poorer sites (classes *Papaveretea rhoeadis*, *Polygono-Poetea annuae*, *Sisymbrietea*, *Artemisietea vulgaris*, *Chenopodietea* and *Digitario sanguinalis-Eragrostietea minoris*) from communities of shady, moist and nutrient-richer sites (classes *Bidentetea* and *Epilobietea angustifolii*). The major contributors to axis 2 (23% variance explained) were disturbance severity and frequency; this axis separated communities preferring less severe and less frequent disturbances (classes *Cymbalario-Parietarietea diffusae*, *Epilobietea angustifolii*) from communities adapted to more severe and more frequent disturbances (classes *Papaveretea rhoeadis*, *Polygono-Poetea annuae*, *Sisymbrietea* and *Digitario sanguinalis-Eragrostietea minoris*).

Discussion

Our synthesis of the anthropogenic vegetation of the northwestern Iberian Peninsula has detected a discrepancy between the number of vegetation units described in the literature (i.e. 34 alliances) and the number supported by numerical classification (25 alliances). Our classification supported that anthropogenic vegetation can be broadly divided into three groups belonging to trampled, weed and ruderal communities. These groups are organized along a principal axis of variation related to abiotic stress and a second axis related to disturbance. These two axes determine the characteristics of the communities in terms of species origins and species traits. This synthesis allows for a better understanding of anthropogenic vegetation, as a first step towards a better integration of this biodiversity asset into ecosystem management and nature-based solutions.

Vegetation and habitat classification of anthropogenic communities

Our analysis supports the existence of 25 anthropogenic alliances in the vegetation of the Iberian Atlantic territories. While the core of this vegetation diversity is made up of temperate European alliances, these are enriched by the occurrence of eight Mediterranean alliances (*Galio valantiae-Parietarion judaicae*, *Polycarpion tetraphylli*, *Allion triquetri*, *Chenopodion muralis*, *Echio-Galactition tomentosae*, *Paspalo-Agrostion semiverticillati*, *Silybo mariani-Urticion piluliferae* and *Balloto-Conion maculati*); plus three alliances that are endemic of the Iberian coasts (*Linario polygalifoliae-Vulpion alopecuri*) and mountains (*Carduo carpetani-Cirsion odontolepidis*, *Cirsion richterano-chodati*) (Mucina et al. 2016). Five of these alliances had been reported as absent or uncertain in the Iberian Atlantic territories (*Chenopodion muralis*) or only present in the Portuguese sector of the area

(*Spergulo arvensis-Erodion cicutariae*, *Allion triquetri*, *Echio-Galactition tomentosae*, *Carduo carpetani-Cirsion odontolepidis*) by the recently published distribution maps of vegetation alliances in Europe (Preislerová et al. 2022).

On the other hand, our dataset does not support the occurrence in the Iberian Atlantic territories of nine alliances (*Caucalidion lappulae*, *Roemerion hybridae*, *Euphorbion prostratae*, *Hordeion murini*, *Taeniathero-Aegilopion geniculatae*, *Onopordion castellani*, *Onopordion acanthii*, *Fragarion vescae* and *Aegopodion podagrariae*) that had been cited as potentially occurring here (Izco et al. 2000; Mucina et al. 2016; Díaz González 2020; Durán Gómez 2020; Preislerová et al. 2022). Of course, the fact that these nine alliances are not supported by our numerical methods only indicates that they are poorly represented in our dataset and should not be taken as absolute proof that they are absent from the Iberian Atlantic territories.

Since our goal was to match the classification to the EuroVegChecklist (Mucina et al. 2016), we refrained from merging recognized alliances or changing their assignation to superior syntaxa. However, there are some cases that could deserve further scrutiny. For example, the two wall alliances (*Galio valantiae-Parietarion judaicae* and *Cymbalario-Asplenion*) had a large overlap in their geographic distribution, their floristic composition, their proportion of alien species, their community traits and their ecological preferences. These two alliances are well recognized in the European literature and they are generally interpreted as representing the Mediterranean (*Galio valantiae-Parietarion judaicae*) and temperate (*Cymbalario-Asplenion*) versions of wall vegetation (Brullo & Guarino 1998; Jasprica et al. 2021). It is therefore not surprising that in biogeographic transitional regions - such as the Iberian Atlantic territories - these two alliances coexist and show a high overlap.

For habitat classification purposes, we propose that this vegetation diversity can be summarized into 25 EUNIS habitat types: two constructed habitats (*J2.5*), three habitats of arable crops and gardens (*V1*), 16 habitats of anthropogenic grasslands (*V3*), two habitats of woodland clearings and fringes (*R5*) and two habitats of periodically-exposed shores (*Q61*). In general, we have followed the correspondence between alliances and EUNIS habitats proposed by the EUNIS expert system (Chytrý et al. 2020), except for *Echio-Galactition tomentosae* which, in the context of the study area, seems to be more adequately placed in the habitat *V37 Annual anthropogenic herbaceous vegetation* rather than in the habitat *V33 Dry Mediterranean land with unpalatable non-vernal herbaceous vegetation*.

Characterization of anthropogenic communities

We found 22% non-native species (including neophytes and archaeophytes) in the anthropogenic vegetation of the Iberian Atlantic territories. This percentage is intermediate between that found in urban areas of temperate Europe and North America (30-50%) (Pyšek 1998; Clemants & Moore 2003; La Sorte et al. 2007; Lososová et al. 2012) and Italy (12-26%) (Celesti-Grapow & Blasi 1998). A survey of anthropogenic vegetation in the north-west Balkans found 13% non-native plants, with more neophytes than archaeophytes (Silc et al. 2012). A similar study in the Czech Republic found 32% archaeophytes and 7% neophytes (Simonova & Lososová 2008). Taken together, these results suggest that the Iberian Atlantic anthropogenic vegetation shows an incidence of non-native species that is intermediate between southern and central-northern Europe, which is in agreement with the biogeographical position of our study area. Previous studies also suggested that the non-natives were more frequent in early successional anthropogenic communities (Pyšek et al. 2004) and our results confirmed this as the proportion of native species tended to be higher in the perennial ruderal classes *Artemisietea vulgaris* and *Epilobietea angustifolii*. The classes with more non-native species also tended to be those adapted to more frequent and more severe disturbances (*Papaveretea rhoeadis*, *Digitario sanguinalis-Eragrostietea minoris*, *Sisymbrietea*), also in agreement with previous research (Simonova & Lososová 2008). Archaeophytes had a higher proportion in the vegetation associated to arable habitats (*Papaveretea rhoeadis*, *Digitario sanguinalis-Eragrostietea minoris*, *Sisymbrietea*), in agreement with the ancient origin of archaeophytes during the development of agriculture (Zohary 1950; Preston et al. 2004). On the other hand, neophytes tended to be in higher proportions in vegetation types associated to wet conditions (*Bidentetea*), as has been found in other European regions (Chytrý et al. 2008).

The traits of the Iberian Atlantic anthropogenic communities agreed with those found in other European regions (Lososová et al. 2006; Silc 2010), with more annual species in habitats associated to arable land and more perennials in ruderal habitats and a general dominance of therophytes and hemicryptophytes in the species pool (Tabasevic, Lakusic, et al. 2021). We found that the main drivers of variation in anthropogenic community composition was a gradient from open-dry to shady-wet sites, supporting the importance of the moisture gradient in shaping anthropogenic vegetation (Golovanov et al. 2023). Mesic and moist human-made habitats of the Iberian Atlantic territories harbor perennial communities, some of which are especially rich in native species and have semi-natural characters. At the same time, the wetter habitats have some of the higher prevalences of non-native species.

Conclusions

The anthropogenic vegetation of the Iberian Atlantic territories is home to more than a thousand plant taxa. This is approximately one third of the whole regional species pool represented in the SIVIM database (Font et al. 2012) and one fifth of the Iberian flora (Ramos-Gutiérrez et al. 2021). More than half of this synanthropic diversity (c. 600 taxa) occurs in mesic to wet perennial ruderal vegetation, highlighting the potential of some anthropogenic habitats as a source of biodiversity in human-dominated landscapes (Anderson & Minor 2017; Kowarik 2018). These results suggest three main objectives for the sustainable management of human-made habitats: (1) focusing efforts on alien plant management in anthropogenic plant communities of wet habitats; (2) conserving examples of archaeophyte-rich annual weed communities, especially those linked to traditional agricultural practices (Meyer et al. 2013); and (3) conserving and promoting mesic ruderal and fringe vegetation as a biodiversity refuge in urban and peri-urban areas. We hope that our synthesis of the anthropogenic communities of the Iberian Atlantic territories serves as a contribution towards a pan-European synthesis of human-made vegetation, a synthesis that could shed light on the coexistence between humans and plants.

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Supplementary Information

Appendix S1 Checklist of anthropogenic syntaxa that could be present in the Iberian Atlantic territories according to the literature. Syntaxa names are provided as recorded by the original authors of the vegetation plot. The file indicates if the presence of the syntaxon in the Iberian Atlantic territories was validated or not by our analysis.

Appendix S2 Original publications providing the vegetation plots stored in SIVIM and used in our analysis. Reference details are provided as they are in the SIVIM database.

Appendix S3 Description of the 25 alliances present in the anthropogenic vegetation of the northwestern Iberian Peninsula, and correspondence with regionalized level 4 EUNIS habitats.

Appendix S4 Characteristic species combinations of the anthropogenic vegetation alliances in spreadsheet format, divided into diagnostic, constant and dominant species. The values are as follows: Diagnostic species = *IndVal* multiplied by 100; Constant species = percentage occurrence frequency (constancy); Dominant species = percentage frequency of plots in which the species occurs with a cover larger than 25%.

Appendix S5 Synoptic table of the fidelity (phi) of the diagnostic species of the 25 anthropogenic alliances.

Appendix S6 Revised checklist of vegetation associations described in the regional literature and belonging to the 25 alliances present in the Iberian Atlantic anthropogenic vegetation.

Figures

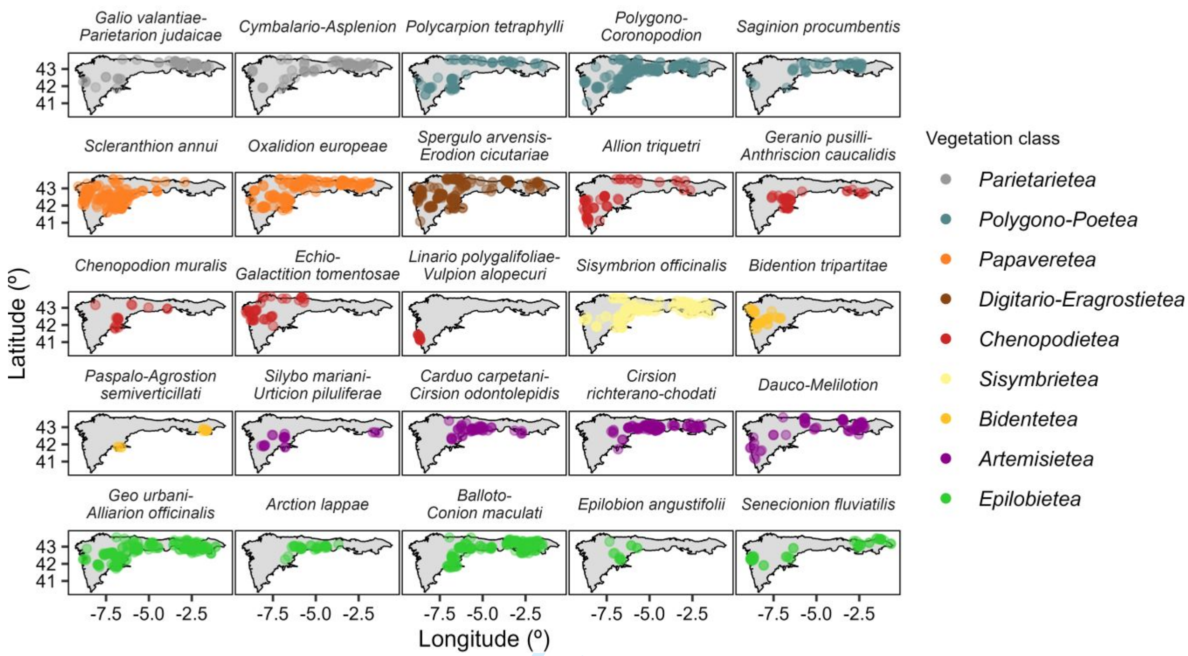

Figure 1: Anthropogenic vegetation alliances of the Iberian Atlantic territories. Each dot is a vegetation plot. Dot colors indicate the vegetation class.

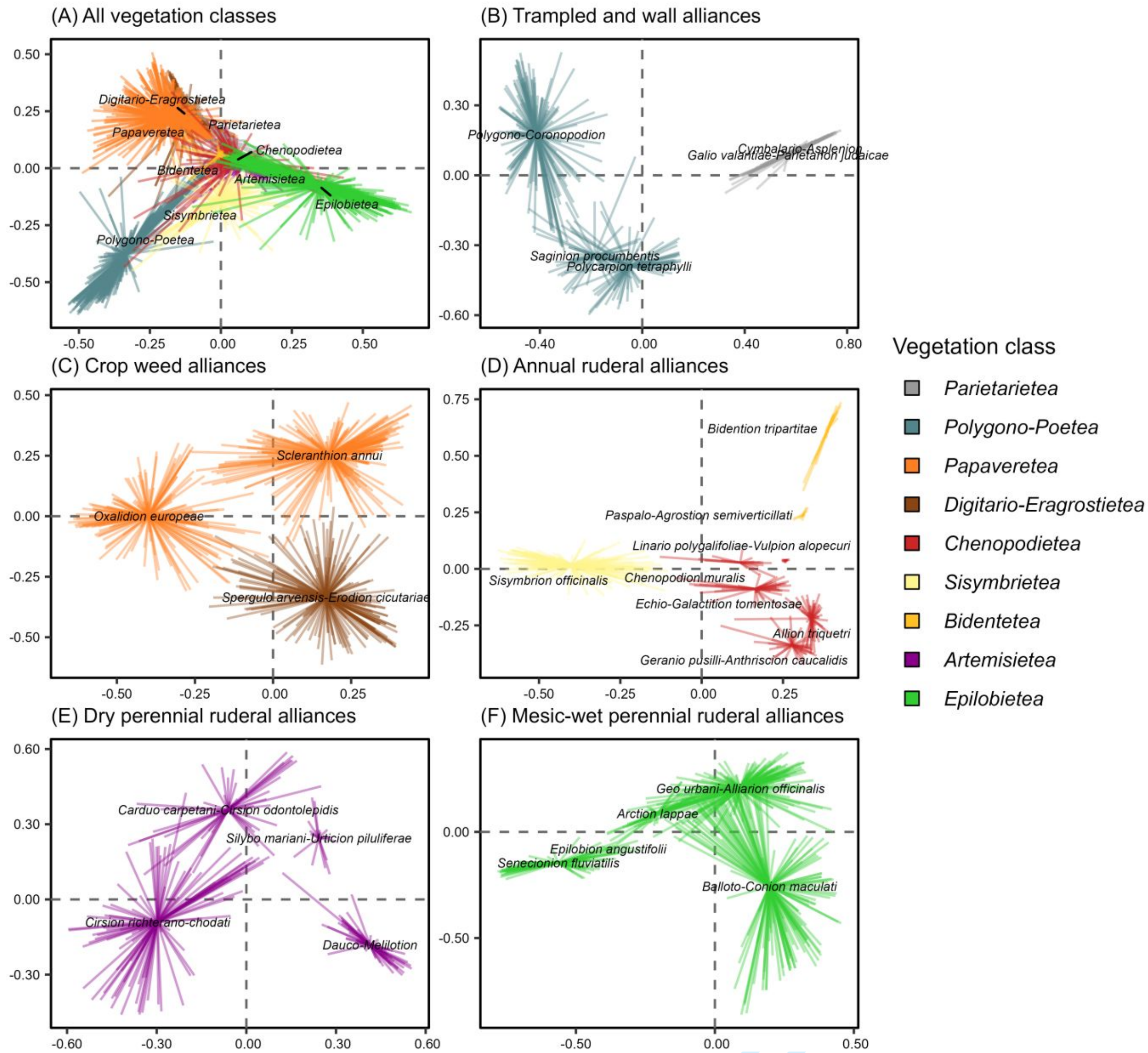

Figure 2: Floristic diversity of the anthropogenic plant communities of the Iberian Atlantic territories. Biplots produced by Principal Component Analysis (PCA) with Hellinger transformation. PCAs were conducted for the whole vegetation (A) and for specific subsets (B-F). Colors indicate the vegetation class.

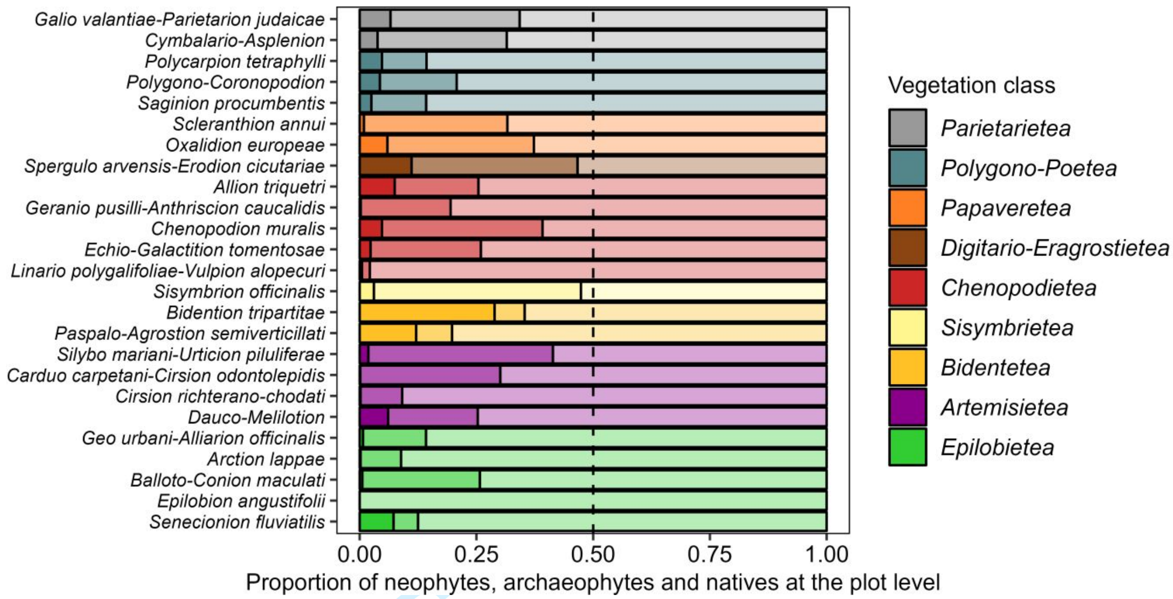

Figure 3: Proportion of neophytes, archaeophytes and native species in the anthropogenic plant communities of the Iberian Atlantic territories. Each bar represents the plot-level average proportion of neophytes (dark shade), archaeophytes (medium shade) and natives (light shade) in each vegetation alliance. Colors indicate the vegetation class.

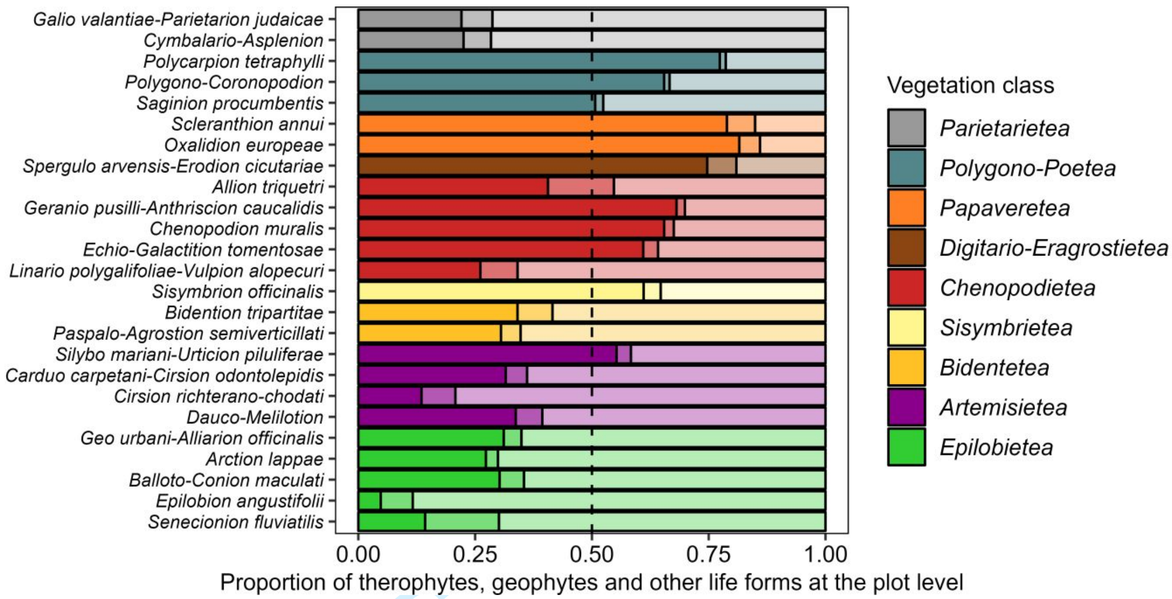

Figure 4: Proportion of therophytes, geophytes and other life forms (hemicryptophytes, chamaephytes, phanerophytes, bryophytes, hydrophytes) in the anthropogenic plant communities of the Iberian Atlantic territories. Each bar represents the plot-level average proportion of therophytes (dark shade), geophytes (medium shade) and other life forms (light shade) in each vegetation alliance. Colors indicate the vegetation class.

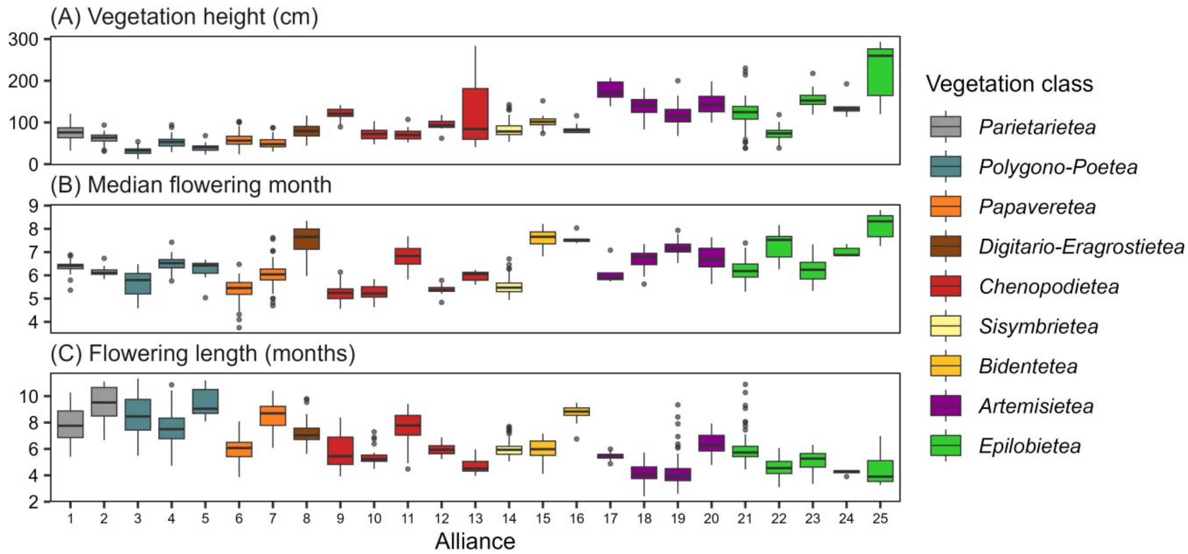

Figure 5: Vegetation height and flowering phenology of the anthropogenic plant communities of the Iberian Atlantic territories. Boxplots show the community-weighted mean for plant height, median month of flowering and length of the flowering season for each vegetation alliance. Colors indicate the vegetation class. Alliances as ordered as in Figures 1 and 3-4 and alliance numbers are the same as listed in Appendix S3.

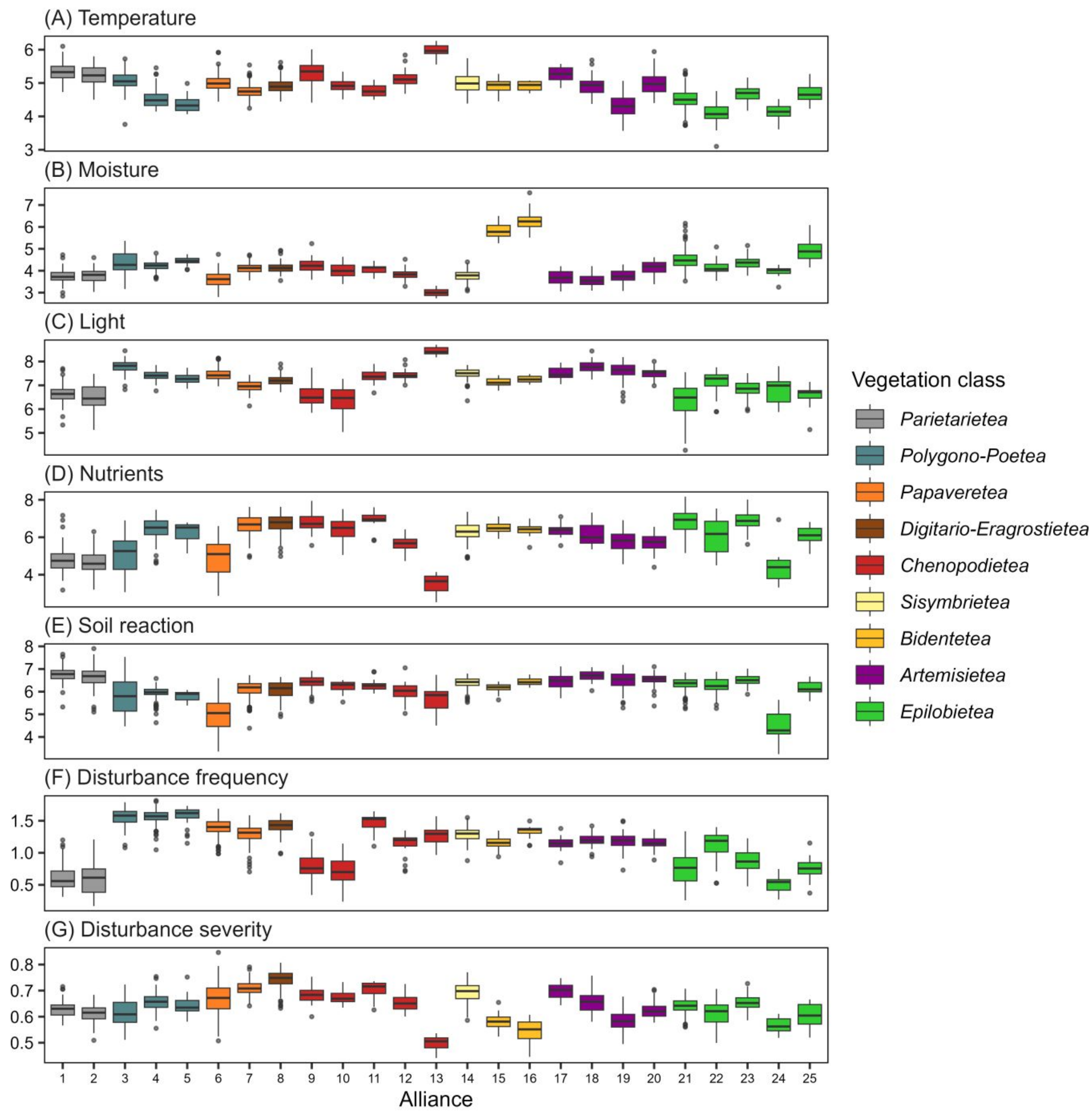

Figure 6: Ecological requirements of the anthropogenic plant communities of the Iberian Atlantic territories. Boxplots show the plot-level means for the ecological indicator values of temperature, moisture, light, nutrients, soil reaction, disturbance frequency and disturbance severity, calculated for each vegetation alliance. Colors indicate the vegetation class.

Alliances as ordered as in Figures 1 and 3-4 and alliance numbers are the same as listed in Appendix S3.

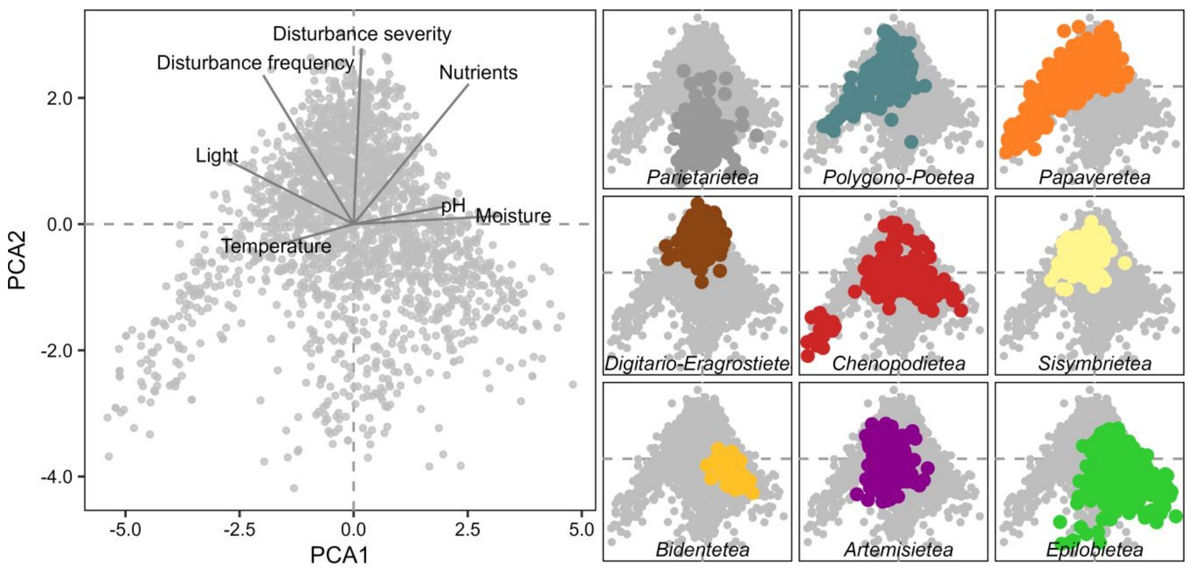

Figure 7: Ecological requirements of the anthropogenic plant communities of the Iberian Atlantic territories. Biplot produced by Principal Component Analysis (PCA) of the plot-level means for the ecological indicator values of temperature, moisture, light, nutrients, soil reaction, disturbance frequency and disturbance severity. Each dot is a plot. In the left panel, labels and arrows indicate the contribution of each indicator to the first and second principal components. The right panels show the space occupied by each vegetation class (colored dots) with respect to the whole anthropogenic vegetation (grey dots).

Original_SI	Alliance	Order	Class	Vegetation	Anthropoge	Iberian_Atl	EUNIS
Carlino cor	Onopordior	Carthameta	Artemisiete	ANTHROP	Yes	No	V38
Onopordet	Onopordior	Carthameta	Artemisiete	ANTHROP	Yes	No	V38
Carduo bou	Silybo mari	Carthameta	Artemisiete	ANTHROP	Yes	Yes	V38
Carduo bou	Silybo mari	Carthameta	Artemisiete	ANTHROP	Yes	Yes	V38
Echio rosul	Silybo mari	Carthameta	Artemisiete	ANTHROP	Yes	Yes	V38
Carduo car	Carduo car	Onopordeta	Artemisiete	ANTHROP	Yes	Yes	V38
Carduo nut	Cirsion rich	Onopordeta	Artemisiete	ANTHROP	Yes	Yes	V38
Carduo nut	Cirsion rich	Onopordeta	Artemisiete	ANTHROP	Yes	Yes	V38
Cirsio chod	Cirsion rich	Onopordeta	Artemisiete	ANTHROP	Yes	Yes	V38
Cirsio chod	Cirsion rich	Onopordeta	Artemisiete	ANTHROP	Yes	Yes	V38
Comunidad	Dauco-Meli	Onopordeta	Artemisiete	ANTHROP	Yes	Yes	V38
Echio rosul	Dauco-Meli	Onopordeta	Artemisiete	ANTHROP	Yes	Yes	V38
Helmintio e	Dauco-Meli	Onopordeta	Artemisiete	ANTHROP	Yes	Yes	V38
Picridi echi	Dauco-Meli	Onopordeta	Artemisiete	ANTHROP	Yes	Yes	V38
Onopordior	Onopordior	Onopordeta	Artemisiete	ANTHROP	Yes	No	V38
Bidentetea	Bidention tr	Bidentetalia	Bidentetea	ANTHROP	Yes	Yes	No relationship
Bidenti tripa	Bidention tr	Bidentetalia	Bidentetea	ANTHROP	Yes	Yes	No relationship
Cypero era	Bidention tr	Bidentetalia	Bidentetea	ANTHROP	Yes	Yes	No relationship
Filaginello	Bidention tr	Bidentetalia	Bidentetea	ANTHROP	Yes	Yes	No relationship
Polygono h	Bidention tr	Bidentetalia	Bidentetea	ANTHROP	Yes	Yes	No relationship
Xanthio ital	Bidention tr	Bidentetalia	Bidentetea	ANTHROP	Yes	Yes	No relationship
Xanthio-Po	Bidention tr	Bidentetalia	Bidentetea	ANTHROP	Yes	Yes	No relationship
Paspalo-Ag	Paspalo-Ag	Paspalo-He	Bidentetea	ANTHROP	Yes	Yes	No relationship
Coleosteph	Echio-Gala	Brometalia	Chenopodi	ANTHROP	Yes	Yes	V33
Bromo scop	Hordeion m	Brometalia	Chenopodi	ANTHROP	Yes	No	V32
Scrophulari	Linario poly	Brometalia	Chenopodi	ANTHROP	Yes	Yes	V32
Medicagini	Taeniather	Brometalia	Chenopodi	ANTHROP	Yes	No	V32
Trifolio che	Taeniather	Brometalia	Chenopodi	ANTHROP	Yes	No	V32
Chenopodi	Chenopodi	Chenopodi	Chenopodi	ANTHROP	Yes	Yes	V37
Chenopodi	Chenopodi	Chenopodi	Chenopodi	ANTHROP	Yes	Yes	V37
Chenopodi	Chenopodi	Chenopodi	Chenopodi	ANTHROP	Yes	Yes	V37
Sisymbrio i	Chenopodi	Chenopodi	Chenopodi	ANTHROP	Yes	Yes	V37
Urtico uren	Chenopodi	Chenopodi	Chenopodi	ANTHROP	Yes	Yes	V37
Allio triquet	Allion trique	Geranio pu	Chenopodi	ANTHROP	Yes	Yes	V37
Chelidonio	Allion trique	Geranio pu	Chenopodi	ANTHROP	Yes	Yes	V37
Urtico-Smy	Allion trique	Geranio pu	Chenopodi	ANTHROP	Yes	Yes	V37
Anthrisco c	Geranio pu	Geranio pu	Chenopodi	ANTHROP	Yes	Yes	V37
Anthrisco-C	Geranio pu	Geranio pu	Chenopodi	ANTHROP	Yes	Yes	V37
Galio apari	Geranio pu	Geranio pu	Chenopodi	ANTHROP	Yes	Yes	V37
Cymbalarie	Cymbalario	Tortulo-Cyr	Cymbalario	VEGETATI	Yes	Yes	No relationship
Cymbalario	Cymbalario	Tortulo-Cyr	Cymbalario	VEGETATI	Yes	Yes	No relationship
Centrantho	Galio valan	Tortulo-Cyr	Cymbalario	VEGETATI	Yes	Yes	U38
Hedero-Pol	Galio valan	Tortulo-Cyr	Cymbalario	VEGETATI	Yes	Yes	U38
Oxalido-Pa	Galio valan	Tortulo-Cyr	Cymbalario	VEGETATI	Yes	Yes	U38
Oxali-Parie	Galio valan	Tortulo-Cyr	Cymbalario	VEGETATI	Yes	Yes	U38
Parietariet	Galio valan	Tortulo-Cyr	Cymbalario	VEGETATI	Yes	Yes	U38
Amarantho	Spergulo a	Eragrostiet	Digitario sa	ANTHROP	Yes	Yes	V11, V12, V13
Asociaci�r	Spergulo a	Eragrostiet	Digitario sa	ANTHROP	Yes	Yes	V11, V12, V13
Asociaci�r	Spergulo a	Eragrostiet	Digitario sa	ANTHROP	Yes	Yes	V11, V12, V13
Asociaci�r	Spergulo a	Eragrostiet	Digitario sa	ANTHROP	Yes	Yes	V11, V12, V13
Chrysanthe	Spergulo a	Eragrostiet	Digitario sa	ANTHROP	Yes	Yes	V11, V12, V13
Comunidad	Spergulo a	Eragrostiet	Digitario sa	ANTHROP	Yes	Yes	V11, V12, V13
Lamio (hyb	Spergulo a	Eragrostiet	Digitario sa	ANTHROP	Yes	Yes	V11, V12, V13
Lamio diss	Spergulo a	Eragrostiet	Digitario sa	ANTHROP	Yes	Yes	V11, V12, V13
Lamio hybr	Spergulo a	Eragrostiet	Digitario sa	ANTHROP	Yes	Yes	V11, V12, V13

Panico-Set	Spergulo a	Eragrostiet	Digitario sa	ANTHROP	Yes	Yes	V11, V12, V13
Panicum cr	Spergulo a	Eragrostiet	Digitario sa	ANTHROP	Yes	Yes	V11, V12, V13
Panicum sa	Spergulo a	Eragrostiet	Digitario sa	ANTHROP	Yes	Yes	V11, V12, V13
Setario ver	Spergulo a	Eragrostiet	Digitario sa	ANTHROP	Yes	Yes	V11, V12, V13
Setario-Ech	Spergulo a	Eragrostiet	Digitario sa	ANTHROP	Yes	Yes	V11, V12, V13
Euphorbiet	Euphorbion	Euphorbiet	Digitario sa	ANTHROP	Yes	No	V34
Gnaphaliio	Euphorbion	Euphorbiet	Digitario sa	ANTHROP	Yes	No	V34
Arction	Arction lap	Arctio lappa	Epilobietea	ANTHROP	Yes	Yes	V39
Chenopodi	Arction lap	Arctio lappa	Epilobietea	ANTHROP	Yes	Yes	V39
Chenopodi	Arction lap	Arctio lappa	Epilobietea	ANTHROP	Yes	Yes	V39
Chenopodi	Arction lap	Arctio lappa	Epilobietea	ANTHROP	Yes	Yes	V39
Galactito to	Arction lap	Arctio lappa	Epilobietea	ANTHROP	Yes	Yes	V39
Geranio lus	Arction lap	Arctio lappa	Epilobietea	ANTHROP	Yes	Yes	V39
Malvo mau	Arction lap	Arctio lappa	Epilobietea	ANTHROP	Yes	Yes	V39
Senecioni c	Arction lap	Arctio lappa	Epilobietea	ANTHROP	Yes	Yes	V39
Balloto foet	Balloto-Cor	Arctio lappa	Epilobietea	ANTHROP	Yes	Yes	V39
Balloto-Cor	Balloto-Cor	Arctio lappa	Epilobietea	ANTHROP	Yes	Yes	V39
Galio apari	Balloto-Cor	Arctio lappa	Epilobietea	ANTHROP	Yes	Yes	V39
Urtico dioic	Balloto-Cor	Arctio lappa	Epilobietea	ANTHROP	Yes	Yes	V39
Chaerophyl	Aegopodion	Circaeo lute	Epilobietea	ANTHROP	Yes	No	V39, R55
Galio apari	Aegopodion	Circaeo lute	Epilobietea	ANTHROP	Yes	No	V39, R55
Atropetum	Fragarion v	Circaeo lute	Epilobietea	ANTHROP	Yes	No	R57
Comunidad	Senecionio	Convolvule	Epilobietea	ANTHROP	Yes	Yes	R55
Convolvulo	Senecionio	Convolvule	Epilobietea	ANTHROP	Yes	Yes	R55
Picridio hie	Senecionio	Convolvule	Epilobietea	ANTHROP	Yes	Yes	R55
Picrido hier	Senecionio	Convolvule	Epilobietea	ANTHROP	Yes	Yes	R55
Arundini-Co	Senecionio	Convolvule	Epilobietea	ANTHROP	Yes	Yes	R55
Asphodelo	Epilobion a	Galeopsio-	Epilobietea	ANTHROP	Yes	Yes	R57
Asphodelo	Epilobion a	Galeopsio-	Epilobietea	ANTHROP	Yes	Yes	R57
Comunidad	Epilobion a	Galeopsio-	Epilobietea	ANTHROP	Yes	Yes	R57
Alliarion pe	Geo urbani	Galio-Alliar	Epilobietea	ANTHROP	Yes	Yes	V39
Geranietum	Geo urbani	Galio-Alliar	Epilobietea	ANTHROP	Yes	Yes	V39
Geranio rot	Geo urbani	Galio-Alliar	Epilobietea	ANTHROP	Yes	Yes	V39
Geranio rot	Geo urbani	Galio-Alliar	Epilobietea	ANTHROP	Yes	Yes	V39
Oxalido ace	Geo urbani	Galio-Alliar	Epilobietea	ANTHROP	Yes	Yes	V39
Comunidad	Oxalidion e	Aperetalia s	Papaverete	ANTHROP	Yes	Yes	V11, V12, V13
Fumario ca	Oxalidion e	Aperetalia s	Papaverete	ANTHROP	Yes	Yes	V11, V12, V13
Holosteo u	Oxalidion e	Aperetalia s	Papaverete	ANTHROP	Yes	Yes	V11, V12, V13
Lamio amp	Oxalidion e	Aperetalia s	Papaverete	ANTHROP	Yes	Yes	V11, V12, V13
Oxalidi latif	Oxalidion e	Aperetalia s	Papaverete	ANTHROP	Yes	Yes	V11, V12, V13
Aphanion a	Scleranthio	Aperetalia s	Papaverete	ANTHROP	Yes	Yes	V11, V12, V13, V15
Catapodiet	Scleranthio	Aperetalia s	Papaverete	ANTHROP	Yes	Yes	V11, V12, V13, V15
Centaureo	Scleranthio	Aperetalia s	Papaverete	ANTHROP	Yes	Yes	V11, V12, V13, V15
Cerutoceph	Scleranthio	Aperetalia s	Papaverete	ANTHROP	Yes	Yes	V11, V12, V13, V15
Chrysanten	Scleranthio	Aperetalia s	Papaverete	ANTHROP	Yes	Yes	V11, V12, V13, V15
Chrysanthe	Scleranthio	Aperetalia s	Papaverete	ANTHROP	Yes	Yes	V11, V12, V13, V15
Cnico bene	Scleranthio	Aperetalia s	Papaverete	ANTHROP	Yes	Yes	V11, V12, V13, V15
Linaria delp	Scleranthio	Aperetalia s	Papaverete	ANTHROP	Yes	Yes	V11, V12, V13, V15
Linario ame	Scleranthio	Aperetalia s	Papaverete	ANTHROP	Yes	Yes	V11, V12, V13, V15
Linario eleg	Scleranthio	Aperetalia s	Papaverete	ANTHROP	Yes	Yes	V11, V12, V13, V15
Linario eleg	Scleranthio	Aperetalia s	Papaverete	ANTHROP	Yes	Yes	V11, V12, V13, V15
Miboro min	Scleranthio	Aperetalia s	Papaverete	ANTHROP	Yes	Yes	V11, V12, V13, V15
Spergularic	Scleranthio	Aperetalia s	Papaverete	ANTHROP	Yes	Yes	V11, V12, V13, V15
Tolpidi bart	Scleranthio	Aperetalia s	Papaverete	ANTHROP	Yes	Yes	V11, V12, V13, V15
Triseto ova	Scleranthio	Aperetalia s	Papaverete	ANTHROP	Yes	Yes	V11, V12, V13, V15
Veronico tri	Roemerion	Gladiolo ita	Papaverete	ANTHROP	Yes	No	V12, V13

Centaureet	Caucalidior	Papavereta	Papaverete	ANTHROP	Yes	No	V11, V13
Crassulo til	Polycarpior	Polygono a	Polygono-F	ANTHROP	Yes	Yes	V34
Polycarpior	Polycarpior	Polygono a	Polygono-F	ANTHROP	Yes	Yes	V34
Polycarpo t	Polycarpior	Polygono a	Polygono-F	ANTHROP	Yes	Yes	V34
Poo annua	Polycarpior	Polygono a	Polygono-F	ANTHROP	Yes	Yes	V34
Coronopod	Polygono-C	Polygono a	Polygono-F	ANTHROP	Yes	Yes	V34
Matricario-I	Polygono-C	Polygono a	Polygono-F	ANTHROP	Yes	Yes	V34
Matricario-I	Polygono-C	Polygono a	Polygono-F	ANTHROP	Yes	Yes	V34
Polycarpo t	Polygono-C	Polygono a	Polygono-F	ANTHROP	Yes	Yes	V34
Polygono a	Polygono-C	Polygono a	Polygono-F	ANTHROP	Yes	Yes	V34
Polygono a	Polygono-C	Polygono a	Polygono-F	ANTHROP	Yes	Yes	V34
Polygono-C	Polygono-C	Polygono a	Polygono-F	ANTHROP	Yes	Yes	V34
Polygono-M	Polygono-C	Polygono a	Polygono-F	ANTHROP	Yes	Yes	V34
Bryo argen	Saginion pr	Polygono a	Polygono-F	ANTHROP	Yes	Yes	V35
Bryo argen	Saginion pr	Polygono a	Polygono-F	ANTHROP	Yes	Yes	V35
Sagino pro	Saginion pr	Polygono a	Polygono-F	ANTHROP	Yes	Yes	V35
Sagino-Bry	Saginion pr	Polygono a	Polygono-F	ANTHROP	Yes	Yes	V35
Bromo diar	Sisymbrion	Sisymbrieta	Sisymbriete	ANTHROP	Yes	Yes	V15, V37, V38
Bromo-Hor	Sisymbrion	Sisymbrieta	Sisymbriete	ANTHROP	Yes	Yes	V15, V37, V38
Comunidac	Sisymbrion	Sisymbrieta	Sisymbriete	ANTHROP	Yes	Yes	V15, V37, V38
Sisymbrio c	Sisymbrion	Sisymbrieta	Sisymbriete	ANTHROP	Yes	Yes	V15, V37, V38

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Appendix S3 Description of the 25 alliances present in the anthropogenic vegetation of the northwestern Iberian Peninsula, and correspondence with regionalized level 4 EUNIS habitats.

Cymbalario-Parietarietea diffusae Chasmophytic vegetation of human-made walls.

1. *Galio valantiae-Parietarion judaicae* Hemicryptophyte-rich vegetation of sunny human-made walls. A predominantly Mediterranean alliance that occupies sunnier situations than the other alliance in the class and has a shorter flowering season. Diagnostic species: *Parietaria judaica*, *Centranthus ruber*, *Polypodium cambricum*, *Asplenium ceterach*, *Hypericum hircinum*. Regionalized level 4 EUNIS habitat: *J25Z Sunny constructed walls with hemicryptophytes - Muros construidos soleados, con hemicriptófitos*.

2. *Cymbalario-Asplenion* Fern-rich vegetation of shady human-made walls. A predominantly temperate alliance that occupies shadier situations than the other alliance in the class and has a longer flowering season. Diagnostic species: *Cymbalaria muralis*, *Asplenium trichomanes*, *Umbilicus rupestris*, *Trachelium caeruleum*, *Asplenium scolopendrium*. Regionalized level 4 EUNIS habitat: *J25Y Shady constructed walls with ferns - Muros contruidos sombríos, con helechos*.

Polygono-Poetea annuae Dwarf-annual vegetation of trampled sites.

3. *Polycarpion tetraphylli* Dwarf-annual vegetation of trampled sunny sites. Occupies warmer, sunnier and nutrient-poorer situations than the other alliances in the class and has an earlier flowering season. Diagnostic species: *Sagina apetala*, *Plantago coronopus*, *Crassula tillaea*, *Spergularia marina*, *Sagina maritima*. Regionalized level 4 EUNIS habitat: *V34Z Trampled sunny soils with annuals - Suelos pisoteados soleados, con céspedes anuales*.

4. *Polygono-Coronopodion* Dwarf-annual vegetation of trampled dry sites. Occupies sites that are shadier than those preferred by *Polycarpion tetraphylli*, but drier than those of *Saginion procumbentis*. Diagnostic species: *Polygonum aviculare*, *Matricaria suaveolens*, *Plantago major*. Regionalized level 4 EUNIS habitat: *V34Y Trampled dry soils with annuals - Suelos pisoteados secos, con céspedes anuales*.

5. *Saginion procumbentis* Bryophyte-rich vegetation of trampled shady sites. Occupies shadier, colder and moister sites than the other alliances in the class, is less dominated by therophytes and has a relatively high proportion of bryophytes. Diagnostic species: *Sagina procumbens*, *Bryum argenteum*, *Ochlopoa annua*. Regionalized level 4 EUNIS habitat: *V35Z Trampled shady soils with bryophytes - Suelos pisoteados sombríos, con briófitos*.

Papaveretea rhoeadis Annual weed vegetation of arable crops and vegetable gardens.

6. *Scleranthion annui* Annual weeds of cereal crops. Occupies more acidic soils than the other alliance in the class, and flowers earlier. Rich in putative archaeophytes. Diagnostic species: *Mibora minima*, *Anthemis arvensis*, *Rumex acetosella*, *Spergula arvensis*, *Raphanus raphanistrum*, *Arnoseris minima*, *Scleranthus annuus*, *Anthoxanthum ovatum*, *Ornithopus compressus*. Regionalized level 4 EUNIS habitat: *V10Z Cereal crops with winter-spring weeds - Cultivos de cereales, con malas hierbas de invierno y primavera*.

7. *Oxalidion europeae* Annual weeds of vegetable gardens and root crops. Occupies wetter, shadier and nutrient-richer sites, and has a longer flowering season than the other alliance in the class. Rich in putative archaeophytes, and with more neophytes than the other alliance in the class. Diagnostic species: *Stellaria media*, *Veronica persica*, *Senecio vulgaris*, *Cardamine hirsuta*, *Veronica hederifolia*, *Euphorbia helioscopia*, *Lamium amplexicaule*, *Fumaria capreolata*. Regionalized level 4 EUNIS habitat:s

V10Y Vegetable gardens and root crops with winter-spring weeds - Huertos y cultivos de raíces, con malas hierbas de invierno y primavera.

Digitario sanguinalis-Eragrostietea minoris Grass-rich weed vegetation with summer-annual C4 species.

8. *Spergulo arvensis-Erodion cicutariae* Late-summer C4 weeds. Late-flowering alliance rich in neophytes and grasses, occurring in highly-disturbed and nutrient-rich sites. Diagnostic species: *Chenopodium album*, *Echinochloa crus-galli*, *Digitaria sanguinalis*, *Solanum nigrum*, *Amaranthus hybridus*, *Fallopia convolvulus*, *Persicaria maculosa*, *Oxalis latifolia*, *Portulaca oleracea*. Regionalized level 4 EUNIS habitat: *V10X Crops with C4 summer weeds - Cultivos, con malas hierbas estivales C4.*

Chenopodietea Winter-annual ruderal vegetation.

9. *Allion triquetri* Geophyte-rich vegetation of shady and nutrient-rich forest fringes. Occupies warmer, shadier and less frequently disturbed situations than the other alliances in the class, is comparatively taller and earlier-flowering. Has a higher proportion of geophytes and a lower proportion of therophytes. The proportion of neophytes is the highest in the class. Diagnostic species: *Urtica membranacea*, *Smyrnium olusatrum*, *Tradescantia fluminensis*, *Allium triquetrum*, *Arum italicum*, *Chelidonium majus*. Regionalized level 4 EUNIS habitat: *V37Z Shady and nutrient-rich forest fringes with geophytes - Orlas forestales escionitrófilas, con geófitos.*

10. *Geranio pusilli-Anthriscion caucalidis* Winter-annual vegetation of shady and nutrient-rich forest fringes. Occupies situations similar to the previous alliance, but in colder sites, and is a shorter vegetation dominated by therophytes instead of geophytes. Diagnostic species: *Geranium lucidum*, *Anthriscus caucalis*. Regionalized level 4 EUNIS habitat: *V37Y Shady and nutrient-rich forest fringes with winter annuals - Orlas forestales escionitrófilas, con vegetación anual de invierno.*

11. *Chenopodion muralis* Winter-annual vegetation of disturbed sites. Short vegetation occupying frequently disturbed sites. Flowers later and for longer than other alliances in the class. Rich in putative archaeophytes. This is a predominantly Mediterranean alliance, and has a sparse occurrence throughout the study area. Diagnostic species: *Malva neglecta*, *Urtica urens*, *Amaranthus deflexus*, *Chenopodiastrum murale*. Regionalized level 4 EUNIS habitat: *V37X Disturbed sites with winter annuals - Lugares alterados, con vegetación anual de invierno.*

12. *Echio-Galactition tomentosae* Sub-nitrophilous and winter-annual pioneer vegetation of abandoned sites. Occupies drier, sunnier and less nutrient-rich situations than other alliances in the class. Diagnostic species: *Galactites tomentosus*, *Coleostephus myconis*, *Anisantha rigida*, *Lolium multiflorum*, *Briza maxima*, *Vicia sativa*, *Silene gallica*, *Crepis capillaris*, *Briza minor*. Regionalized level 4 EUNIS habitat: *V37W Subnitrophilous disturbed sites with annual pioneer vegetation - Lugares alterados subnitrófilos, con vegetación pionera anual.*

13. *Linario polygalifoliae-Vulpion alopecuri* Ephemeral annual vegetation of disturbed coastal dunes. Occupies warm, dry and sunny coastal sites, and has a high number of coastal dune species. Isolated occurrence in the southern coast of the region. Diagnostic species: *Vulpia alopecuros*, *Crucianella maritima*, *Malcolmia littorea*, *Artemisia campestris* (full list in **Appendix S4**). Regionalized level 4 EUNIS habitat: *V32Z Disturbed dunes with ephemeral vegetation - Dunas alteradas, con vegetación anual efímera.*

Sisymbrietea Summer-annual ruderal vegetation.

14. *Sisymbrion officinalis* Summer-annual ruderal vegetation. Rich in therophytes and archaeophytes and adapted to severe disturbances. Diagnostic species: *Hordeum murinum*, *Sisymbrium officinale*, *Lolium perenne*. Regionalized level 4 EUNIS habitat: *V37V Disturbed sites with summer annuals - Lugares alterados, con vegetación anual de verano.*

Bidentetea Summer-annual pioneer vegetation of temporarily flooded sites.

15. *Bidention tripartitae* Summer-annual pioneer vegetation of temporarily flooded sites. Occupies nutrient-richer sites than the other alliance in the class and has a higher proportion of therophytes and neophytes. Diagnostic species: *Persicaria hydropiper*, *Bidens frondosus*, *Lythrum salicaria*, *Phalaroides arundinacea*,

Cyperus eragrostis (full list in **Appendix S4**). Regionalized level 4 EUNIS habitat: *Q61Z Temporarily flooded soils, with summer-annual pioneer vegetation - Suelos temporalmente encharcados, con vegetación pionera anual.*

16. *Paspalo-Agrostion semiverticillati* Mediterranean summer-annual pioneer vegetation of temporarily flooded subsaline sites. Occupies wetter and more frequently disturbed sites than the other alliance in the class and has a longer flowering season. This is a Mediterranean alliance, which in the study area is distributed mostly in the sub-Mediterranean valleys south of the Cantabrian Mountains. Diagnostic species: *Paspalum distichum*, *Cyperus longus*, *Schoenoplectus lacustris* (full list in **Appendix S4**). Regionalized level 4 EUNIS habitat: *Q61Y Submediterranean temporarily flooded soils, with summer-annual pioneer grasslands - Suelos temporalmente encharcados submediterráneos, con céspedes pioneros anuales.*

Artemisietea vulgaris Perennial ruderal vegetation of dry sites.

17. *Silybo mariani-Urticion piluliferae* Mediterranean thistle-dominated vegetation. Occupies sites that are warmer and more severely disturbed than the other alliances in the class. Is taller and flowers earlier than the other alliances. Rich in archaeophytes and therophytes. This is a Mediterranean alliance, which in the study area is distributed mostly in the sub-Mediterranean valleys south of the Cantabrian Mountains. Diagnostic species: *Silybum marianum*, *Carduus tenuiflorus*, *Anisantha diandra*. Regionalized level 4 EUNIS habitat: *V38Z Mediterranean thistle fields - Cardales mediterráneos.*

18. *Carduo carpetani-Cirsion odontolepidis* Supramediterranean thistle-dominated vegetation of the Cantabrian Mountains. Occupies warmer situations than the other alliances in the class and has a high proportion of archaeophytes. Mostly distributed in the Cantabrian Mountains. Diagnostic species: *Onopordum acanthium*, *Reseda luteola*, *Verbascum pulverulentum*, *Lactuca virosa*, *Echium vulgare*. Regionalized level 4 EUNIS habitat: *V38Y Supramediterranean thistle fields of the Cantabrian Mountains - Cardales supramediterráneos orocantábricos.*

19. *Cirsion richterano-chodati* Montane thistle fields of the Cantabrian Mountains. Occupies colder situations than the other alliances in the class. Mostly distributed in the Cantabrian Mountains. Diagnostic species: *Cirsium eriophorum*, *Carduus carpetanus*, *Carduus nutans*, *Jacobaea vulgaris*, *Cirsium richterianum*, *Cirsium arvense*, *Achillea millefolium*. Regionalized level 4 EUNIS habitat: *V38X Montane thistle fields of the Cantabrian Mountains - Cardales montanos orocantábricos.*

20. *Dauco-Melilotion* Biennial pioneer vegetation of abandoned sites. Occupies wetter situations than the thistle alliances in the class and has a higher proportion of neophytes. Diagnostic species: *Helminthotheca echioides*, *Daucus carota*, *Melilotus albus*, *Foeniculum vulgare*, *Erigeron canadensis* (full list in **Appendix S4**). Regionalized level 4 EUNIS habitat: *V38W Dry disturbed sites with biennal pioneer vegetation - Lugares alterados secos, con vegetación pionera bienal.*

Epilobietea angustifolii Perennial ruderal vegetation of mesic to wet sites.

21. *Geo urbani-Alliarion officinalis* Perennial vegetation of shady and nutrient-rich forest fringes. Occupies shadier and less frequently disturbed situations than the other alliances in the class. Includes tall-herb vegetation of forest fringes, which some authors separate as *Aegopodion podagrariae*. Diagnostic species: *Urtica dioica*, *Pentaglottis sempervirens*, *Galium aparine*, *Lamium maculatum*, *Anthriscus sylvestris*. Regionalized level 4 EUNIS habitat: *V39Z Shady and nutrient-rich forest fringes with perennial vegetation - Orlas forestales escionitrófilas, con vegetación perenne.*

22. *Arction lappae* Perennial vegetation of disturbed mesic sites of the Cantabrian Mountains. Occupies sunnier and more frequently disturbed situations than the other alliances in the class, and has shorter plants. Distribution concentrated in the Cantabrian Mountains. Diagnostic species: *Oxybasis rubra*, *Senecio duriaei*. Regionalized level 4 EUNIS habitat: *V39Y Mesic disturbed sites of the Cantabrian Mountains, with perennial vegetation - Lugares alterados mésicos orocantábricos, con vegetación perenne.*

23. *Balloto-Conion maculati* Tall-herb perennial vegetation of mesic to moist disturbed sites. Occupies warmer situations than the other alliances in the class. Rich in archaeophytes. Diagnostic species: *Sambucus ebulus*, *Conium maculatum*. Regionalized level 4 EUNIS habitat: *V39X Mesic to moist*

disturbed sites, with tall-herb perennial vegetation - Lugares alterados de mésicos a húmedos, con megaforbios perennes.

24. *Epilobion angustifolii* Tall-herb perennial vegetation of forest fringes in acidic soils. Occupies colder, nutrient-poorer, more acidic and less disturbed situations than the other alliances in the class. Diagnostic species: *Epilobium angustifolium*, *Digitalis purpurea*, *Avenella flexuosa*, *Luzula lactea* (full list in **Appendix S4**). Regionalized level 4 EUNIS habitat: *R57Z Forest fringes and clearings on acid soils, with fire-loving tall-herb vegetation - Orlas y claros forestales de suelos ácidos, con megaforbios pirófitos.*

25. *Senecionion fluviatilis* Tall-herb perennial vegetation of nutrient-rich riverbanks and ditches. Occupies wetter situations than the other alliances in the class, flowers later, has taller plants and has a high proportion of neophytes and geophytes. Diagnostic species: *Eupatorium cannabinum*, *Arundo donax*, *Angelica sylvestris*, *Picris hieracioides*, *Mentha suaveolens*, *Pteridium aquilinum*, *Centaurea debeauxii*, *Silene latifolia*. Regionalized level 4 EUNIS habitat: *R55Z Fringes of nutrient-rich ditches and riverbanks, with tall-herb perennial vegetation - Orlas nitrófilas de cunetas y arroyos, con megaforbios.*

Alliance	CANTEUNI	Species	Type	Value
Allion trique	V37Z	Urtica mem	Constant	67.85714
Allion trique	V37Z	Sonchus ol	Constant	58.92857
Allion trique	V37Z	Urtica mem	Diagnostic	64.10405
Allion trique	V37Z	Smyrnium (	Diagnostic	46.15511
Allion trique	V37Z	Tradescant	Diagnostic	35.2228
Allion trique	V37Z	Allium triqu	Diagnostic	33.92857
Allion trique	V37Z	Arum italicu	Diagnostic	29.21639
Allion trique	V37Z	Chelidoniur	Diagnostic	21.5306
Allion trique	V37Z	Smyrnium (	Dominant	46.42857
Allion trique	V37Z	Urtica mem	Dominant	44.64286
Allion trique	V37Z	Tradescant	Dominant	14.28571
Allion trique	V37Z	Urtica dioic	Dominant	10.71429
Allion trique	V37Z	Allium triqu	Dominant	7.142857
Arction lapp	V39Y	Urtica dioic	Constant	87.5
Arction lapp	V39Y	Oxybasis ru	Constant	77.5
Arction lapp	V39Y	Senecio du	Constant	72.5
Arction lapp	V39Y	Oxybasis ru	Diagnostic	76.49011
Arction lapp	V39Y	Senecio du	Diagnostic	69.18861
Arction lapp	V39Y	Cytisus oro	Diagnostic	17.5
Arction lapp	V39Y	Oxybasis ru	Dominant	47.5
Arction lapp	V39Y	Senecio du	Dominant	20
Arction lapp	V39Y	Blitum bonu	Dominant	7.5
Arction lapp	V39Y	Urtica dioic	Dominant	7.5
Balloto-Cor	V39X	Urtica dioic	Constant	94.48276
Balloto-Cor	V39X	Galium apa	Constant	75.86207
Balloto-Cor	V39X	Sambucus	Constant	71.72414
Balloto-Cor	V39X	Sambucus	Diagnostic	70.06688
Balloto-Cor	V39X	Conium ma	Diagnostic	30.30553
Balloto-Cor	V39X	Sambucus	Dominant	52.41379
Balloto-Cor	V39X	Conium ma	Dominant	29.65517
Balloto-Cor	V39X	Urtica dioic	Dominant	24.13793
Balloto-Cor	V39X	Galium apa	Dominant	11.72414
Bidention tr	Q61Z	Lythrum sa	Constant	100
Bidention tr	Q61Z	Persicaria l	Constant	100
Bidention tr	Q61Z	Bidens fron	Constant	96.9697
Bidention tr	Q61Z	Phalaroides	Constant	75.75758
Bidention tr	Q61Z	Cyperus er	Constant	72.72727
Bidention tr	Q61Z	Lycopus eu	Constant	72.72727
Bidention tr	Q61Z	Helosciadiu	Constant	60.60606
Bidention tr	Q61Z	Dysphania	Constant	57.57576
Bidention tr	Q61Z	Rumex obtu	Constant	57.57576
Bidention tr	Q61Z	Persicaria l	Diagnostic	99.59581
Bidention tr	Q61Z	Bidens fron	Diagnostic	96.9171
Bidention tr	Q61Z	Lythrum sa	Diagnostic	77.43444
Bidention tr	Q61Z	Phalaroides	Diagnostic	74.72024
Bidention tr	Q61Z	Cyperus er	Diagnostic	70.20233
Bidention tr	Q61Z	Helosciadiu	Diagnostic	58.236
Bidention tr	Q61Z	Dysphania	Diagnostic	55.401
Bidention tr	Q61Z	Lycopus eu	Diagnostic	49.97051
Bidention tr	Q61Z	Xanthium o	Diagnostic	45.45455
Bidention tr	Q61Z	Agrostis sto	Diagnostic	39.04176
Bidention tr	Q61Z	Artemisia v	Diagnostic	39.00259
Bidention tr	Q61Z	Mentha pul	Diagnostic	37.02199
Bidention tr	Q61Z	Solanum ch	Diagnostic	30.30303
Bidention tr	Q61Z	Galium palu	Diagnostic	27.27273

Bidention tr	Q61Z	Symphyotri	Diagnostic	26.47763
Bidention tr	Q61Z	Veronica be	Diagnostic	24.24242
Bidention tr	Q61Z	Cuscuta ca	Diagnostic	24.24242
Bidention tr	Q61Z	Leersia ory	Diagnostic	24.01439
Bidention tr	Q61Z	Setaria par	Diagnostic	21.21212
Bidention tr	Q61Z	Galinsoga (	Diagnostic	20.9517
Bidention tr	Q61Z	Setaria fab	Diagnostic	18.18182
Bidention tr	Q61Z	Bidens fron	Dominant	84.84848
Bidention tr	Q61Z	Persicaria l	Dominant	75.75758
Bidention tr	Q61Z	Xanthium o	Dominant	27.27273
Bidention tr	Q61Z	Artemisia v	Dominant	12.12121
Bidention tr	Q61Z	Lythrum sa	Dominant	12.12121
Bidention tr	Q61Z	Dysphania	Dominant	6.060606
Bidention tr	Q61Z	Helosciadiu	Dominant	6.060606
Bidention tr	Q61Z	Symphyotri	Dominant	6.060606
Carduo car	V38Y	Onopordun	Constant	93.47826
Carduo car	V38Y	Carduus ca	Constant	65.21739
Carduo car	V38Y	Echium vul	Constant	63.04348
Carduo car	V38Y	Dipsacus fu	Constant	56.52174
Carduo car	V38Y	Lactuca vir	Constant	54.34783
Carduo car	V38Y	Rumex cris	Constant	50
Carduo car	V38Y	Onopordun	Diagnostic	90.00202
Carduo car	V38Y	Reseda lut	Diagnostic	30.04185
Carduo car	V38Y	Verbascum	Diagnostic	28.17033
Carduo car	V38Y	Lactuca vir	Diagnostic	25.34966
Carduo car	V38Y	Echium vul	Diagnostic	24.58333
Carduo car	V38Y	Onopordun	Dominant	45.65217
Carduo car	V38Y	Echium vul	Dominant	6.521739
Carduo car	V38Y	Carduus ca	Dominant	6.521739
Chenopodi	V37X	Malva negl	Constant	87.5
Chenopodi	V37X	Polygonum	Constant	68.75
Chenopodi	V37X	Plantago la	Constant	56.25
Chenopodi	V37X	Urtica uren	Constant	56.25
Chenopodi	V37X	Ochlopoa a	Constant	50
Chenopodi	V37X	Malva negl	Diagnostic	76.34121
Chenopodi	V37X	Urtica uren	Diagnostic	54.46286
Chenopodi	V37X	Amaranthu	Diagnostic	36.37225
Chenopodi	V37X	Chenopodi	Diagnostic	17.98137
Chenopodi	V37X	Urtica uren	Dominant	25
Chenopodi	V37X	Amaranthu	Dominant	18.75
Chenopodi	V37X	Atriplex ros	Dominant	12.5
Chenopodi	V37X	Artemisia a	Dominant	6.25
Chenopodi	V37X	Polygonum	Dominant	6.25
Chenopodi	V37X	Malva negl	Dominant	6.25
Cirsion rich	V38X	Cirsium eri	Constant	63.63636
Cirsion rich	V38X	Carduus ca	Constant	63.63636
Cirsion rich	V38X	Jacobaea v	Constant	55.55556
Cirsion rich	V38X	Cirsium vul	Constant	54.54545
Cirsion rich	V38X	Cirsium arv	Constant	51.51515
Cirsion rich	V38X	Cirsium eri	Diagnostic	60.80085
Cirsion rich	V38X	Carduus ca	Diagnostic	38.91876
Cirsion rich	V38X	Carduus nu	Diagnostic	35.62455
Cirsion rich	V38X	Jacobaea v	Diagnostic	33.42127
Cirsion rich	V38X	Cirsium rich	Diagnostic	27.01468
Cirsion rich	V38X	Cirsium arv	Diagnostic	26.66082
Cirsion rich	V38X	Achillea mil	Diagnostic	23.17133

Cirsion rich V38X	Cirsium eri	Dominant	22.22222
Cirsion rich V38X	Cirsium rich	Dominant	19.19192
Cirsion rich V38X	Carduus ca	Dominant	15.15152
Cirsion rich V38X	Carduus nu	Dominant	9.090909
Cirsion rich V38X	Cirsium arv	Dominant	8.080808
Cirsion rich V38X	Jacobaea v	Dominant	5.050505
Cymbalario J25Y	Cymbalaria	Constant	100
Cymbalario J25Y	Asplenium	Constant	68.33333
Cymbalario J25Y	Parietaria ju	Constant	51.66667
Cymbalario J25Y	Cymbalaria	Diagnostic	79.10059
Cymbalario J25Y	Asplenium	Diagnostic	32.34954
Cymbalario J25Y	Umbilicus r	Diagnostic	17.86141
Cymbalario J25Y	Trachelium	Diagnostic	17.0919
Cymbalario J25Y	Asplenium	Diagnostic	16.317
Cymbalario J25Y	Cymbalaria	Dominant	56.66667
Dauco-Meli V38W	Daucus car	Constant	91.04478
Dauco-Meli V38W	Helminthotl	Constant	65.67164
Dauco-Meli V38W	Plantago la	Constant	56.71642
Dauco-Meli V38W	Foeniculum	Constant	53.73134
Dauco-Meli V38W	Holcus lana	Constant	52.23881
Dauco-Meli V38W	Dactylis glo	Constant	50.74627
Dauco-Meli V38W	Helminthotl	Diagnostic	58.04877
Dauco-Meli V38W	Daucus car	Diagnostic	54.09703
Dauco-Meli V38W	Melilotus al	Diagnostic	46.6534
Dauco-Meli V38W	Foeniculum	Diagnostic	37.21829
Dauco-Meli V38W	Erigeron ca	Diagnostic	31.99631
Dauco-Meli V38W	Hypericum	Diagnostic	27.34812
Dauco-Meli V38W	Lotus tenui	Diagnostic	23.32654
Dauco-Meli V38W	Dipsacus fu	Diagnostic	22.75573
Dauco-Meli V38W	Medicago li	Diagnostic	21.14478
Dauco-Meli V38W	Verbena of	Diagnostic	20.78779
Dauco-Meli V38W	Pulicaria dy	Diagnostic	19.06908
Dauco-Meli V38W	Holcus lana	Diagnostic	16.58436
Dauco-Meli V38W	Foeniculum	Dominant	23.8806
Dauco-Meli V38W	Melilotus al	Dominant	20.89552
Dauco-Meli V38W	Helminthotl	Dominant	16.41791
Dauco-Meli V38W	Dipsacus fu	Dominant	10.44776
Dauco-Meli V38W	Daucus car	Dominant	5.970149
Dauco-Meli V38W	Erigeron ca	Dominant	5.970149
Echio-Gala V37W	Galactites t	Constant	100
Echio-Gala V37W	Vicia sativa	Constant	65
Echio-Gala V37W	Daucus car	Constant	65
Echio-Gala V37W	Sonchus ol	Constant	65
Echio-Gala V37W	Dactylis glo	Constant	65
Echio-Gala V37W	Plantago la	Constant	62.5
Echio-Gala V37W	Coleosteph	Constant	60
Echio-Gala V37W	Lolium mult	Constant	52.5
Echio-Gala V37W	Geranium c	Constant	50
Echio-Gala V37W	Geranium r	Constant	50
Echio-Gala V37W	Holcus lana	Constant	50
Echio-Gala V37W	Galactites t	Diagnostic	94.66652
Echio-Gala V37W	Coleosteph	Diagnostic	44.54142
Echio-Gala V37W	Anisantha r	Diagnostic	40.81005
Echio-Gala V37W	Lolium mult	Diagnostic	40.24579
Echio-Gala V37W	Briza maxir	Diagnostic	28.40214
Echio-Gala V37W	Vicia sativa	Diagnostic	27.66217

Echio-Gala V37W	Silene galli	Diagnostic	18.13213
Echio-Gala V37W	Crepis capi	Diagnostic	17.91607
Echio-Gala V37W	Briza minor	Diagnostic	16.62444
Echio-Gala V37W	Galactites t	Dominant	70
Echio-Gala V37W	Anisantha r	Dominant	22.5
Echio-Gala V37W	Coleosteph	Dominant	12.5
Echio-Gala V37W	Echium vul	Dominant	10
Echio-Gala V37W	Arctotheca	Dominant	5
Echio-Gala V37W	Convolvulu	Dominant	5
Echio-Gala V37W	Medicago a	Dominant	5
Echio-Gala V37W	Mentha sua	Dominant	5
Epilobion a R57Z	Epilobium a	Constant	100
Epilobion a R57Z	Digitalis pu	Constant	83.33333
Epilobion a R57Z	Avenella fle	Constant	50
Epilobion a R57Z	Epilobium a	Diagnostic	99.69062
Epilobion a R57Z	Digitalis pu	Diagnostic	75.33349
Epilobion a R57Z	Avenella fle	Diagnostic	48.60143
Epilobion a R57Z	Luzula lacte	Diagnostic	41.66667
Epilobion a R57Z	Linaria trior	Diagnostic	31.08797
Epilobion a R57Z	Vaccinium	Diagnostic	25
Epilobion a R57Z	Helictochlo	Diagnostic	25
Epilobion a R57Z	Peucedanu	Diagnostic	25
Epilobion a R57Z	Eryngium d	Diagnostic	25
Epilobion a R57Z	Asphodelus	Diagnostic	19.03432
Epilobion a R57Z	Anemone r	Diagnostic	16.66667
Epilobion a R57Z	Betula celti	Diagnostic	16.66667
Epilobion a R57Z	Lilium mart	Diagnostic	16.66667
Epilobion a R57Z	Hypericum	Diagnostic	16.66667
Epilobion a R57Z	Erica arbor	Diagnostic	16.66667
Epilobion a R57Z	Helleborus	Diagnostic	16.57373
Epilobion a R57Z	Silene nuta	Diagnostic	16.48182
Epilobion a R57Z	Cytisus scc	Diagnostic	16.38773
Epilobion a R57Z	Epilobium a	Dominant	66.66667
Epilobion a R57Z	Avenella fle	Dominant	8.333333
Galio valan J25Z	Parietaria ju	Constant	97.36842
Galio valan J25Z	Cymbalaria	Constant	78.94737
Galio valan J25Z	Asplenium	Constant	57.89474
Galio valan J25Z	Centranthu	Constant	53.94737
Galio valan J25Z	Parietaria ju	Diagnostic	75.47006
Galio valan J25Z	Centranthu	Diagnostic	47.63883
Galio valan J25Z	Polypodium	Diagnostic	30.71036
Galio valan J25Z	Asplenium	Diagnostic	28.43584
Galio valan J25Z	Hypericum	Diagnostic	19.22332
Galio valan J25Z	Parietaria ju	Dominant	39.47368
Galio valan J25Z	Centranthu	Dominant	13.15789
Galio valan J25Z	Hypericum	Dominant	6.578947
Galio valan J25Z	Cymbalaria	Dominant	5.263158
Galio valan J25Z	Erigeron ka	Dominant	5.263158
Geo urbani V39Z	Urtica dioic	Constant	95.79439
Geo urbani V39Z	Galium apa	Constant	68.69159
Geo urbani V39Z	Urtica dioic	Diagnostic	43.12362
Geo urbani V39Z	Pentaglottis	Diagnostic	19.66142
Geo urbani V39Z	Galium apa	Diagnostic	19.39245
Geo urbani V39Z	Lamium ma	Diagnostic	18.30535
Geo urbani V39Z	Anthriscus	Diagnostic	18.11108
Geo urbani V39Z	Urtica dioic	Dominant	62.14953

Geo urbani V39Z	Galium apa	Dominant	16.35514
Geo urbani V39Z	Anthriscus	Dominant	12.61682
Geo urbani V39Z	Geranium r	Dominant	6.542056
Geo urbani V39Z	Pentaglottis	Dominant	6.542056
Geranio pu V37Y	Geranium I	Constant	100
Geranio pu V37Y	Galium apa	Constant	77.77778
Geranio pu V37Y	Anisantha s	Constant	58.33333
Geranio pu V37Y	Anthriscus	Constant	58.33333
Geranio pu V37Y	Geranium I	Diagnostic	87.11324
Geranio pu V37Y	Anthriscus	Diagnostic	53.64557
Geranio pu V37Y	Geranium I	Dominant	66.66667
Geranio pu V37Y	Anthriscus	Dominant	22.22222
Geranio pu V37Y	Geranium r	Dominant	5.555556
Linario poly V32Z	Vulpia alop	Constant	70.83333
Linario poly V32Z	Crucianella	Constant	62.5
Linario poly V32Z	Artemisia c	Constant	62.5
Linario poly V32Z	Jasione mc	Constant	62.5
Linario poly V32Z	Malcolmia l	Constant	62.5
Linario poly V32Z	Helichrysur	Constant	58.33333
Linario poly V32Z	Ammophila	Constant	58.33333
Linario poly V32Z	Leontodon	Constant	54.16667
Linario poly V32Z	Vulpia alop	Diagnostic	70.83333
Linario poly V32Z	Crucianella	Diagnostic	62.5
Linario poly V32Z	Malcolmia l	Diagnostic	62.5
Linario poly V32Z	Artemisia c	Diagnostic	62.38579
Linario poly V32Z	Ammophila	Diagnostic	58.33333
Linario poly V32Z	Helichrysur	Diagnostic	58.33333
Linario poly V32Z	Leontodon	Diagnostic	54.16667
Linario poly V32Z	Jasione mc	Diagnostic	52.84128
Linario poly V32Z	Corynepho	Diagnostic	41.66667
Linario poly V32Z	Linaria poly	Diagnostic	41.66667
Linario poly V32Z	Scrophulari	Diagnostic	39.72469
Linario poly V32Z	Seseli tortu	Diagnostic	37.5
Linario poly V32Z	Cistus salvi	Diagnostic	33.33333
Linario poly V32Z	Carex aren	Diagnostic	33.33333
Linario poly V32Z	Festuca jur	Diagnostic	32.62787
Linario poly V32Z	Pinus pinas	Diagnostic	29.16667
Linario poly V32Z	Lagurus ov	Diagnostic	29.16667
Linario poly V32Z	Eryngium n	Diagnostic	29.16667
Linario poly V32Z	Calystegia	Diagnostic	25
Linario poly V32Z	Filago pygr	Diagnostic	25
Linario poly V32Z	Euphorbia	Diagnostic	25
Linario poly V32Z	Anagallis m	Diagnostic	25
Linario poly V32Z	Corema alb	Diagnostic	25
Linario poly V32Z	Tuberaria g	Diagnostic	22.74091
Linario poly V32Z	Herniaria ci	Diagnostic	20.83333
Linario poly V32Z	Daphne gn	Diagnostic	20.83333
Linario poly V32Z	Silene port	Diagnostic	20.83333
Linario poly V32Z	Pancratium	Diagnostic	20.83333
Linario poly V32Z	Achillea ma	Diagnostic	20.83333
Linario poly V32Z	Leontodon	Diagnostic	20.83157
Linario poly V32Z	Cerastium	Diagnostic	18.22723
Linario poly V32Z	Sedum are	Diagnostic	17.37719
Linario poly V32Z	Armeria pu	Diagnostic	16.66667
Linario poly V32Z	Medicago r	Diagnostic	16.66667
Linario poly V32Z	Iberis procu	Diagnostic	16.66667

Linario poly	V32Z	Trifolium sc	Diagnostic	15.89862
Linario poly	V32Z	Sedum acr	Diagnostic	15.01938
Linario poly	V32Z	Scirpoides	Diagnostic	12.5
Linario poly	V32Z	Vulpia alop	Dominant	20.83333
Linario poly	V32Z	Artemisia c	Dominant	16.66667
Linario poly	V32Z	Carex aren	Dominant	8.333333
Linario poly	V32Z	Cistus salvi	Dominant	8.333333
Linario poly	V32Z	Corema alb	Dominant	8.333333
Linario poly	V32Z	Crucianella	Dominant	8.333333
Oxalidion e	V10Y	Stellaria m	Constant	97.23757
Oxalidion e	V10Y	Senecio vu	Constant	71.8232
Oxalidion e	V10Y	Veronica p	Constant	69.06077
Oxalidion e	V10Y	Ochlopoa a	Constant	65.74586
Oxalidion e	V10Y	Sonchus ol	Constant	62.43094
Oxalidion e	V10Y	Stellaria m	Diagnostic	65.76612
Oxalidion e	V10Y	Veronica p	Diagnostic	57.38442
Oxalidion e	V10Y	Senecio vu	Diagnostic	36.34916
Oxalidion e	V10Y	Cardamine	Diagnostic	28.3384
Oxalidion e	V10Y	Veronica h	Diagnostic	23.84527
Oxalidion e	V10Y	Euphorbia	Diagnostic	20.40947
Oxalidion e	V10Y	Lamium am	Diagnostic	18.26148
Oxalidion e	V10Y	Fumaria ca	Diagnostic	16.32195
Oxalidion e	V10Y	Stellaria m	Dominant	62.43094
Oxalidion e	V10Y	Ochlopoa a	Dominant	13.25967
Oxalidion e	V10Y	Veronica p	Dominant	10.49724
Paspalo-Ag	Q61Y	Paspalum	Constant	100
Paspalo-Ag	Q61Y	Persicaria l	Constant	75
Paspalo-Ag	Q61Y	Cyperus lo	Constant	68.75
Paspalo-Ag	Q61Y	Lythrum sa	Constant	62.5
Paspalo-Ag	Q61Y	Lycopus eu	Constant	50
Paspalo-Ag	Q61Y	Schoenopl	Constant	50
Paspalo-Ag	Q61Y	Paspalum	Diagnostic	96.86308
Paspalo-Ag	Q61Y	Cyperus lo	Diagnostic	60.2535
Paspalo-Ag	Q61Y	Schoenopl	Diagnostic	50
Paspalo-Ag	Q61Y	Xanthium s	Diagnostic	36.15728
Paspalo-Ag	Q61Y	Persicaria l	Diagnostic	32.35253
Paspalo-Ag	Q61Y	Eleocharis	Diagnostic	31.25
Paspalo-Ag	Q61Y	Juncus arti	Diagnostic	25
Paspalo-Ag	Q61Y	Rorippa syl	Diagnostic	25
Paspalo-Ag	Q61Y	Bidens trip	Diagnostic	21.02909
Paspalo-Ag	Q61Y	Persicaria	Diagnostic	18.75
Paspalo-Ag	Q61Y	Paspalum	Dominant	100
Paspalo-Ag	Q61Y	Xanthium s	Dominant	6.25
Paspalo-Ag	Q61Y	Eleocharis	Dominant	6.25
Polycarpion	V34Z	Ochlopoa a	Constant	69.56522
Polycarpion	V34Z	Plantago c	Constant	57.97101
Polycarpion	V34Z	Sagina ape	Constant	56.52174
Polycarpion	V34Z	Sagina ape	Diagnostic	49.50414
Polycarpion	V34Z	Plantago c	Diagnostic	38.64292
Polycarpion	V34Z	Crassula til	Diagnostic	35.10327
Polycarpion	V34Z	Spergularia	Diagnostic	33.33333
Polycarpion	V34Z	Sagina ma	Diagnostic	24.63768
Polycarpion	V34Z	Spergularia	Dominant	21.73913
Polycarpion	V34Z	Ochlopoa a	Dominant	13.04348
Polycarpion	V34Z	Crassula til	Dominant	5.797101
Polycarpion	V34Z	Plantago c	Dominant	5.797101

Polygono-C V34Y	Ochlopoa a	Constant	96.9697
Polygono-C V34Y	Polygonum	Constant	96.36364
Polygono-C V34Y	Matricaria s	Constant	60.60606
Polygono-C V34Y	Plantago m	Constant	54.54545
Polygono-C V34Y	Polygonum	Diagnostic	58.18493
Polygono-C V34Y	Matricaria s	Diagnostic	56.10118
Polygono-C V34Y	Plantago m	Diagnostic	20.25034
Polygono-C V34Y	Polygonum	Dominant	27.87879
Polygono-C V34Y	Ochlopoa a	Dominant	16.9697
Polygono-C V34Y	Matricaria s	Dominant	10.90909
Saginion pr V35Z	Ochlopoa a	Constant	95.45455
Saginion pr V35Z	Sagina pro	Constant	72.72727
Saginion pr V35Z	Bryum arge	Constant	68.18182
Saginion pr V35Z	Polygonum	Constant	52.27273
Saginion pr V35Z	Plantago m	Constant	50
Saginion pr V35Z	Sagina pro	Diagnostic	70.89424
Saginion pr V35Z	Bryum arge	Diagnostic	67.76985
Saginion pr V35Z	Ochlopoa a	Diagnostic	26.75949
Saginion pr V35Z	Ochlopoa a	Dominant	29.54545
Saginion pr V35Z	Sagina pro	Dominant	15.90909
Saginion pr V35Z	Bryum arge	Dominant	15.90909
Scleranthio V10Z	Anthemis a	Constant	68.93617
Scleranthio V10Z	Raphanus	Constant	57.44681
Scleranthio V10Z	Spergula a	Constant	50.6383
Scleranthio V10Z	Mibora min	Diagnostic	37.51846
Scleranthio V10Z	Anthemis a	Diagnostic	35.9069
Scleranthio V10Z	Rumex ace	Diagnostic	33.34348
Scleranthio V10Z	Spergula a	Diagnostic	31.65794
Scleranthio V10Z	Raphanus	Diagnostic	31.29628
Scleranthio V10Z	Arnoseris n	Diagnostic	28.26082
Scleranthio V10Z	Scleranthus	Diagnostic	27.19573
Scleranthio V10Z	Anthoxanth	Diagnostic	22.62382
Scleranthio V10Z	Ornithopus	Diagnostic	16.27535
Scleranthio V10Z	Mibora min	Dominant	8.93617
Scleranthio V10Z	Anthemis a	Dominant	7.659574
Scleranthio V10Z	Spergula a	Dominant	5.531915
Senecionio R55Z	Pteridium a	Constant	59.67742
Senecionio R55Z	Mentha sua	Constant	59.67742
Senecionio R55Z	Picris hiera	Constant	54.83871
Senecionio R55Z	Calystegia	Constant	53.22581
Senecionio R55Z	Eupatorium	Constant	51.6129
Senecionio R55Z	Eupatorium	Diagnostic	49.9488
Senecionio R55Z	Arundo dor	Diagnostic	48.3871
Senecionio R55Z	Angelica sy	Diagnostic	39.54789
Senecionio R55Z	Picris hiera	Diagnostic	27.93518
Senecionio R55Z	Mentha sua	Diagnostic	19.94396
Senecionio R55Z	Pteridium a	Diagnostic	19.0832
Senecionio R55Z	Centaurea	Diagnostic	15.70254
Senecionio R55Z	Silene latifo	Diagnostic	15.18969
Senecionio R55Z	Arundo dor	Dominant	48.3871
Senecionio R55Z	Eupatorium	Dominant	30.64516
Senecionio R55Z	Mentha sua	Dominant	9.677419
Senecionio R55Z	Angelica sy	Dominant	8.064516
Silybo mari V38Z	Silybum ma	Constant	100
Silybo mari V38Z	Anisantha (	Constant	73.68421
Silybo mari V38Z	Carduus te	Constant	68.42105

Silybo mari V38Z	Galium apa	Constant	52.63158
Silybo mari V38Z	Silybum ma	Diagnostic	98.05555
Silybo mari V38Z	Carduus te	Diagnostic	38.22666
Silybo mari V38Z	Anisantha (	Diagnostic	26.06501
Silybo mari V38Z	Silybum ma	Dominant	94.73684
Silybo mari V38Z	Carduus te	Dominant	10.52632
Silybo mari V38Z	Anisantha (	Dominant	5.263158
Silybo mari V38Z	Ballota nigr	Dominant	5.263158
Silybo mari V38Z	Conium ma	Dominant	5.263158
Silybo mari V38Z	Echium ros	Dominant	5.263158
Silybo mari V38Z	Foeniculum	Dominant	5.263158
Silybo mari V38Z	Galium apa	Dominant	5.263158
Sisymbrion V37V	Hordeum m	Constant	100
Sisymbrion V37V	Sisymbrium	Constant	73.37662
Sisymbrion V37V	Lolium pere	Constant	52.5974
Sisymbrion V37V	Anisantha s	Constant	51.94805
Sisymbrion V37V	Hordeum m	Diagnostic	78.49878
Sisymbrion V37V	Sisymbrium	Diagnostic	50.1
Sisymbrion V37V	Lolium pere	Diagnostic	16.66002
Sisymbrion V37V	Hordeum m	Dominant	60.38961
Sisymbrion V37V	Sisymbrium	Dominant	16.23377
Spergulo ai V10X	Chenopodi	Constant	83.61582
Spergulo ai V10X	Persicaria r	Constant	67.79661
Spergulo ai V10X	Echinochlo	Constant	62.14689
Spergulo ai V10X	Stellaria me	Constant	60.45198
Spergulo ai V10X	Digitaria sa	Constant	54.80226
Spergulo ai V10X	Chenopodi	Diagnostic	59.7061
Spergulo ai V10X	Echinochlo	Diagnostic	45.72803
Spergulo ai V10X	Digitaria sa	Diagnostic	39.74022
Spergulo ai V10X	Solanum ni	Diagnostic	35.53685
Spergulo ai V10X	Amaranthu	Diagnostic	34.11671
Spergulo ai V10X	Fallopia coi	Diagnostic	30.22422
Spergulo ai V10X	Persicaria r	Diagnostic	26.59844
Spergulo ai V10X	Oxalis latifc	Diagnostic	23.36528
Spergulo ai V10X	Portulaca o	Diagnostic	19.60207
Spergulo ai V10X	Chenopodi	Dominant	12.99435
Spergulo ai V10X	Amaranthu	Dominant	11.86441
Spergulo ai V10X	Echinochlo	Dominant	10.16949
Spergulo ai V10X	Digitaria sa	Dominant	7.344633

Alliance	*Galio valantiae-Parietarion judaicae*	*Cymbalario-Asplenion*	Polycarpion tetraphylli	Polygono-Coronopodion	Saginion procumbentis	Scleranthion annui	Oxalidion europeae	Spergulo arvensis-Erodion cicutariae	Allion triquetri	Geranio pusilli-Anthriscion caucalidis	Chenopodion muralis	Echio-Galactition tomentosae	Linario polygalifoliae-Vulpion alopecuri	Sisymbrion officinalis	Bidention tripartitae	Paspalo-Agrostion semiverticillati	Silybo mariani-Urticion piluliferae	Carduo carpetani-Cirsion odontolepidis	Cirsion richterano-chodati	Dauco-Melilotion	Geo urbani-Alliarion officinalis	Arction lappae	Balloto-Conion maculati	Epilobion angustifolii	Senecionion fluviatilis
Nº of plots	76	60	69	165	44	235	181	177	56	36	16	40	24	154	33	16	19	46	99	67	214	40	145	12	62
Galio valantiae-Parietarion judaicae																									
Centranthus ruber	57.7	26.7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hypericum hircinum	40	5.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Asplenium adiantum-nigrum aggr.	33	22.8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Origanum vulgare	31	.	.	.	.	.	.	.	.	1.5	.	.	.	.	.	.	.	.	.	10.8	.	.	12.9	.	.
Erigeron karvinskianus	30.2	1.9	.	.	.	.	.	.	6.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cymbalario-Asplenion																									
Trachelium caeruleum	6.2	39.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Asplenium scolopendrium	1.3	36.6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
Polycarpion tetraphylli																									
Sagina apetala	.	.	57.2	2	23.1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Crassula tillaea	.	.	57	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Spergularia marina	.	.	57	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sagina maritima	.	.	48.4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Plantago coronopus	.	.	45	7.1	.	.	.	.	.	.	16.6	.	20.2	.	.	.	.	.	.	.	.	.	.	.	.
Polygono-Coronopodion																									

Matricaria suaveolens	·	·	·	61.6	1.1	·	·	·	·	·	16.4	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Polygonum aviculare	·	·	2.8	45.1	20.6	·	·	8.2	·	·	29.7	·	·	4.9	·	1.9	·	·	·	·	·	·	·	·	·
Plantago major	·	·	·	30.7	27.6	·	·	·	·	·	14.8	·	·	3.7	12.1	·	·	·	·	4.7	·	·	·	·	·
Polygono-Coronopodion																									
Bryum argenteum	·	·	·	·	81.1	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Sagina procumbens	0.5	5.3	·	·	75.8	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Scleranthion annui																									
Mibora minima	·	·	·	·	·	59.7	14.4	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Scleranthus annuus	·	·	·	·	·	50	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Spergula arvensis	·	·	·	·	·	47.4	12.7	17.2	·	·	·	3.5	·	·	·	·	·	·	·	·	·	·	·	·	·
Arnoseris minima	·	·	·	·	·	47.1	·	·	·	·	·	·	4.7	·	·	·	·	·	·	·	·	·	·	·	·
Rumex acetosella	·	·	·	·	·	44.5	6.7	7.5	·	·	·	·	·	·	·	·	1	·	·	·	·	8.1	·	4	·
Raphanus raphanistrum aggr.	·	·	·	·	·	44	8.7	17.2	1.1	·	0.4	5.7	·	·	·	·	·	·	·	2.7	·	·	·	·	·
Anthoxanthum ovatum	·	·	·	·	·	42.4	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Anthemis arvensis	·	·	·	·	·	41.9	4.5	4	·	·	2.4	5.9	·	3.7	·	·	19.4	·	·	·	·	0.7	·	·	·
Linaria elegans	·	·	·	·	·	40.3	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Glebionis segetum	·	·	·	·	·	37.2	0.6	22.6	·	·	·	0.3	·	·	·	·	·	·	·	·	·	·	·	·	·
Hypochaeris glabra	·	·	4.5	·	·	33.7	1.8	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Myosotis discolor	·	·	·	·	·	33.5	6.5	·	·	3.3	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Ornithopus compressus	·	·	·	·	·	33.3	1.5	0	·	·	·	27.5	·	·	·	·	·	·	·	·	·	·	·	·	·
Stachys arvensis	·	·	·	·	·	33.1	23.6	17.2	·	·	·	1.9	·	·	·	·	·	·	·	·	·	·	·	·	·
Linaria amethystea	·	·	·	·	·	30.1	1.9	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Oxalidion europeae																									
Veronica persica	·	·	·	·	·	1.4	53.3	15	·	·	0.2	5.5	·	·	·	·	·	·	·	·	·	·	·	·	·
Cardamine hirsuta	·	·	0.8	·	·	1.1	44.1	·	·	11	2.8	·	·	·	·	·	·	·	·	·	0.6	·	·	·	·
Stellaria media	·	·	·	·	·	13.1	43.1	23.4	6.3	13.3	7.7	4.4	·	·	·	·	·	·	·	·	0.5	·	·	·	·
Senecio vulgaris	·	·	·	·	·	16.6	42.8	15.7	·	·	2.1	3.9	·	0.2	·	·	·	·	·	·	·	·	·	·	·
Euphorbia helioscopia	·	·	·	·	·	5.8	37.3	13	0.9	·	4.1	·	·	·	·	·	·	·	·	·	·	·	·	·	·

Fumaria capreolata	·	·	·	·	·	·	37.2	·	7.6	·	·	·	·	0.2	·	·	·	·	·	·	·	·	·	·	·
Veronica hederifolia	·	·	·	·	0.1	10.5	36.4	·	·	·	5.6	·	·	·	·	·	·	·	·	·	·	0.5	·	·	·
Lamium purpureum aggr.	·	·	·	·	·	3.5	32.9	0.8	2.3	2.6	3.3	1.9	·	·	·	·	·	·	·	·	0.5	·	0.2	·	3.6
Cerastium glomeratum	·	·	0.2	·	·	21.3	32	·	·	0	·	28	·	·	·	·	·	·	·	·	·	·	·	·	·
Lamium amplexicaule	·	·	·	·	0.1	8.7	31.9	4.8	·	·	5.6	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Spergulo arvensis-Erodion cicutari																									
Chenopodium album	·	·	·	·	·	·	5.6	57.7	·	·	18	·	·	4.1	·	·	·	2.5	·	2.2	·	·	·	·	·
Digitaria sanguinalis	·	·	·	·	·	·	0.2	54.1	·	·	2.7	·	·	·	15.3	·	1.6	·	·	·	·	·	·	·	·
Amaranthus hybridus aggr.	·	·	·	·	·	·	·	52.6	·	·	·	·	·	·	1.5	·	4.8	·	·	·	·	·	·	·	·
Echinochloa crus-galli	·	·	·	·	·	·	1.1	48	·	·	·	·	·	·	28.6	21.7	·	·	·	·	·	·	·	·	·
Oxalis latifolia	·	·	·	·	·	·	2.7	45.3	·	·	·	·	·	1.2	·	·	·	·	·	·	·	·	·	·	·
Solanum nigrum	·	·	·	·	·	·	5.1	44.2	·	·	8.8	·	·	·	·	2.4	·	·	·	5.2	·	·	·	·	·
Persicaria maculosa	·	·	·	·	·	4.6	3.7	43.6	·	·	·	·	·	·	7.3	26	·	·	·	0.6	·	·	·	·	2.3
Fallopia convolvulus	·	·	·	·	·	2.6	4	41	·	·	·	1.2	·	·	·	8.9	1.4	·	·	·	·	·	·	·	6
Portulaca oleracea	·	·	·	·	·	·	·	37.5	·	·	·	·	·	·	·	·	7.5	·	·	·	·	·	·	·	·
Setaria verticilliformis	·	·	·	·	·	·	·	31.7	·	·	·	·	·	·	5.8	·	·	·	·	·	·	·	·	·	·
Allion triquetri																									
Urtica membranacea	·	·	·	·	·	·	2.7	·	69.3	·	·	6.9	·	·	·	·	·	·	·	·	·	·	·	·	·
Smyrnium olusatrum	·	·	·	·	·	·	·	·	64.9	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Allium triquetrum	·	·	·	·	·	·	·	·	57.3	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Tradescantia fluminensis	·	·	·	·	·	·	·	·	50.1	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	11.6
Arum italicum	·	·	·	·	·	0.3	10.8	·	49.1	0	·	·	·	·	·	·	·	·	·	·	4.6	·	·	·	·
Oenanthe crocata	·	·	·	·	·	·	·	·	35.3	0.7	·	0.3	·	·	13.2	·	4	·	·	·	·	·	·	·	·
Arisarum vulgare	·	·	·	·	·	4.5	·	·	33	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Chelidonium majus	1.7	4.9	·	·	·	·	·	·	32.5	8.6	·	·	·	·	·	·	·	·	·	·	10.5	·	·	·	12.2
Geranium purpureum	·	·	·	·	·	·	·	·	30.2	26.5	·	·	·	·	·	·	3.9	·	·	0.9	·	·	·	·	·
Geranio pusilli-Anthriscion caucalidis																									
Geranium lucidum	·	·	·	·	·	·	·	·	10.8	70.9	·	·	·	·	·	·	6.5	·	·	·	14.8	·	·	·	·

Anthriscus caucalis	.	.	.	.	.	.	.	.	.	60.3	3.1	.	.	0.5	.	.	2	1	.	.	.	.	.	.	.
Galium spurium	.	.	.	.	.	.	.	.	.	36	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chenopodion muralis																									
Malva neglecta	.	.	.	.	.	.	.	0.8	.	.	69.7	5.7	.	.	.	.	.	.	0.2	.	.	5.7	.	.	.
Urtica urens	.	.	.	.	.	.	0	.	.	.	59.5	7.6	.	.	.	.	2.2	.	.	.	.	.	.	.	.
Amaranthus deflexus	.	.	1.5	.	.	.	.	0.6	.	.	52.8	.	.	0.1	.	.	.	.	.	.	.	.	.	.	.
Chenopodiastrum murale	.	.	.	.	.	.	.	0.7	.	.	39.8	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Atriplex rosea	.	.	.	.	.	.	.	.	.	.	34.8	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Echio-Galactition tomentosae																									
Galactites tomentosus	.	.	.	.	.	.	.	.	2.7	.	.	80.6	.	.	.	.	4	.	.	5.3	.	.	.	.	.
Anisantha rigida	.	2.6	.	.	.	.	.	.	.	.	.	53.9	.	12.3	.	.	.	.	.	0.2	.	.	.	.	.
Lolium multiflorum	.	.	.	.	.	4.6	2.5	1.4	.	.	.	51.5	.	1.6	.	.	.	.	.	.	.	.	4.1	.	.
Coleostephus myconis	.	.	.	.	.	14.5	4.8	1.5	0.2	.	.	49.5	.	.	3.5	.	.	.	.	0.7	.	.	.	.	.
Briza maxima	.	.	.	.	.	.	.	.	.	2.1	.	46.7	.	0.7	.	.	.	.	.	.	.	.	.	.	.
Vicia sativa aggr.	.	.	.	.	.	17	11.9	.	.	7.3	.	39.2	.	2.4	.	.	8.5	.	.	.	.	.	.	.	.
Briza minor	.	.	.	.	.	2.7	.	.	.	.	.	35.7	.	.	.	.	.	.	.	3.5	.	.	.	.	.
Vicia hirsuta	.	.	.	.	.	21.1	3.1	0.4	.	0.3	.	34.9	.	.	.	.	.	.	.	.	.	.	.	.	.
Avena sativa	.	.	.	.	.	.	.	.	.	.	.	34.1	.	.	.	.	8.9	.	.	.	.	.	.	.	.
Silene gallica	.	.	.	.	.	1.7	.	2.6	.	.	.	32.1	.	2.6	.	.	17.1	.	.	.	.	.	.	.	.
Rumex acetosa	.	.	.	.	.	.	.	.	8	.	.	31.4	.	.	.	.	.	.	.	.	3.8	3	1.1	7.2	0.8
Anagallis arvensis	.	.	.	.	.	4.9	7.3	13.1	.	.	0.9	31.3	.	.	.	.	.	.	.	6.1	.	.	.	.	.
Anthoxanthum odoratum	.	.	.	.	.	8	.	.	.	.	.	30.8	.	.	.	.	.	.	.	3.9	.	.	.	9.7	.
Lotus hispidus	.	.	.	.	.	.	.	0.5	.	.	.	30.2	.	.	.	.	.	.	.	.	.	.	.	.	.
Linario polygalifoliae-Vulpion alopecuri																									
Vulpia alopecuros	.	.	.	.	.	.	.	.	.	.	.	.	83.7	.	.	.	.	.	.	.	.	.	.	.	.
Crucianella maritima	.	.	.	.	.	.	.	.	.	.	.	.	78.5	.	.	.	.	.	.	.	.	.	.	.	.
Malcolmia littorea	.	.	.	.	.	.	.	.	.	.	.	.	78.5	.	.	.	.	.	.	.	.	.	.	.	.
Artemisia campestris aggr.	.	.	.	.	.	.	.	.	.	.	.	.	77.1	.	.	.	.	.	.	.	.	.	.	.	.

Helichrysum italicum	.	.	.	.	.	.	.	.	.	.	.	.	75.7	.	.	.	.	.	.	.	.	.	.	.	.
Ammophila arenaria aggr.	.	.	.	.	.	.	.	.	.	.	.	.	75.7	.	.	.	.	.	.	.	.	.	.	.	.
Leontodon tingitanus	.	.	.	.	.	.	.	.	.	.	.	.	72.9	.	.	.	.	.	.	.	.	.	.	.	.
Corynephorus canescens	.	.	.	.	.	.	.	.	.	.	.	.	63.8	.	.	.	.	.	.	.	.	.	.	.	.
Linaria polygalifolia	.	.	.	.	.	.	.	.	.	.	.	.	63.8	.	.	.	.	.	.	.	.	.	.	.	.
Scrophularia canina aggr.	.	.	.	.	.	.	.	.	.	.	.	.	61	.	.	.	.	0.7	.	.	.	.	.	.	.
Jasione montana	.	.	.	.	.	4.8	.	.	.	.	.	.	60.7	.	.	.	.	.	.	.	.	.	.	21.9	.
Seseli tortuosum	.	.	.	.	.	.	.	.	.	.	.	.	60.5	.	.	.	.	.	.	.	.	.	.	.	.
Cistus salviifolius	.	.	.	.	.	.	.	.	.	.	.	.	57	.	.	.	.	.	.	.	.	.	.	.	.
Carex arenaria	.	.	.	.	.	.	.	.	.	.	.	.	57	.	.	.	.	.	.	.	.	.	.	.	.
Festuca juncifolia	.	0.6	.	.	.	.	.	.	.	.	.	.	55.5	.	.	.	.	.	.	.	.	.	.	.	.
Pinus pinaster	.	.	.	.	.	.	.	.	.	.	.	.	53.3	.	.	.	.	.	.	.	.	.	.	.	.
Eryngium maritimum	.	.	.	.	.	.	.	.	.	.	.	.	53.3	.	.	.	.	.	.	.	.	.	.	.	.
Lagurus ovatus	.	.	.	.	.	.	.	.	.	.	.	.	52.6	.	.	.	.	.	.	.	.	.	.	.	.
Corema album	.	.	.	.	.	.	.	.	.	.	.	.	49.3	.	.	.	.	.	.	.	.	.	.	.	.
Filago pygmaea aggr.	.	.	.	.	.	.	.	.	.	.	.	.	49.3	.	.	.	.	.	.	.	.	.	.	.	.
Anagallis monelli	.	.	.	.	.	.	.	.	.	.	.	.	49	.	.	.	.	.	.	.	.	.	.	.	.
Calystegia soldanella	.	.	.	.	.	.	.	.	.	.	.	.	49	.	.	.	.	.	.	.	.	.	.	.	.
Euphorbia portlandica	.	.	.	.	.	.	.	.	.	.	.	.	49	.	.	.	.	.	.	.	.	.	.	.	.
Daphne gnidium	.	.	.	.	.	.	.	.	.	.	.	.	44.9	.	.	.	.	.	.	.	.	.	.	.	.
Pancratium maritimum	.	.	.	.	.	.	.	.	.	.	.	.	44.9	.	.	.	.	.	.	.	.	.	.	.	.
Achillea maritima	.	.	.	.	.	.	.	.	.	.	.	.	44.9	.	.	.	.	.	.	.	.	.	.	.	.
Silene portensis	.	.	.	.	.	.	.	.	.	.	.	.	44.9	.	.	.	.	.	.	.	.	.	.	.	.
Herniaria ciliolata	.	.	.	.	.	.	.	.	.	.	.	.	44.7	.	.	.	.	.	.	.	.	.	.	.	.
Cerastium diffusum	.	.	.	.	.	0.9	.	.	.	.	.	.	43.3	.	.	.	.	.	.	.	.	.	.	.	.
Tuberaria guttata	.	.	8.3	.	.	.	.	.	.	.	.	.	43.2	.	.	.	.	.	.	.	.	.	.	.	.
Sedum arenarium	.	.	0.2	.	.	8.2	.	.	.	.	.	.	41.7	.	.	.	.	.	.	.	.	.	.	.	.
Medicago marina	.	.	.	.	.	.	.	.	.	.	.	.	40.2	.	.	.	.	.	.	.	.	.	.	.	.

Armeria pungens	·	·	·	·	·	·	·	·	·	·	·	·	40.2	·	·	·	·	·	·	·	·	·	·	·	·
Iberis procumbens	·	·	·	·	·	·	·	·	·	·	·	·	40.2	·	·	·	·	·	·	·	·	·	·	·	·
Briza media	·	·	·	·	·	·	·	·	·	·	·	·	38.9	·	·	·	·	·	·	·	·	·	·	·	·
Trifolium scabrum	·	·	1.8	·	·	·	·	·	·	·	·	·	38.4	·	·	·	·	·	·	·	·	·	·	·	·
Sedum acre	·	·	·	·	·	·	·	·	·	·	·	·	36.3	·	·	·	·	·	·	·	·	16.3	·	·	·
Leontodon saxatilis aggr.	·	·	1.7	·	1.9	0.1	·	·	·	·	·	2.4	36	·	·	·	·	·	·	8.9	·	·	·	·	·
Euphorbia paralias	·	·	·	·	·	·	·	·	·	·	·	·	34.8	·	·	·	·	·	·	·	·	·	·	·	·
Silene littorea	·	·	·	·	·	·	·	·	·	·	·	·	34.8	·	·	·	·	·	·	·	·	·	·	·	·
Scirpoides holoschoenus	·	·	·	·	·	·	·	·	·	·	·	·	34.1	·	·	·	·	·	·	·	·	·	·	·	·
Medicago littoralis	·	·	·	·	·	·	·	·	·	·	·	·	32.9	2.1	·	·	·	·	·	·	·	·	·	·	·
Ornithopus pinnatus	·	·	·	·	·	0.1	·	·	·	·	·	17.2	30.4	·	·	·	·	·	·	·	·	·	·	·	2.5
Sisymbrion officinalis																									
Hordeum murinum	·	·	·	1.7	·	·	·	·	·	3.6	10.5	12.7	·	50.9	·	·	20	12.6	·	·	·	·	3.1	·	·
Sisymbrium officinale	·	·	·	·	·	·	·	·	·	·	3.6	7.3	·	49.2	·	·	25.8	4	·	·	0.5	·	0.4	·	·
Lolium perenne	·	·	·	26.8	1.5	·	·	·	·	·	19.6	·	·	30.1	·	·	4.6	·	·	5	·	·	·	·	·
Bidention tripartitae																									
Bidens frondosus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	96.6	·	·	·	·	·	·	·	·	·	·
Persicaria hydropiper	·	·	·	·	·	·	·	·	·	·	·	·	·	·	93.2	·	·	·	·	·	·	·	·	·	5.1
Phalaroides arundinacea	·	·	·	·	·	·	·	·	·	·	·	·	·	·	82.4	·	2.3	·	·	·	·	·	·	·	·
Cyperus eragrostis	·	·	·	·	·	·	·	·	0.3	·	·	·	·	·	77.2	·	·	·	·	·	·	·	·	·	3.5
Dysphania ambrosioides	·	·	·	·	·	·	·	·	·	·	·	·	·	·	70.3	·	·	·	·	2.5	·	·	·	·	·
Xanthium orientale	·	·	·	·	·	·	·	·	·	·	·	·	·	·	66.7	·	·	·	·	·	·	·	·	·	·
Helosciadium nodiflorum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	64.2	17.3	·	·	·	·	·	·	·	·	·
Artemisia verlotiorum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	56.7	·	5.2	·	·	·	·	·	·	·	·
Solanum chenopodioides	·	·	·	·	·	·	·	·	·	·	·	·	·	·	54.1	·	·	·	·	·	·	·	·	·	·
Mentha pulegium	·	·	·	·	·	·	·	·	·	·	·	·	·	·	53.8	20.3	·	·	·	·	·	·	·	·	·
Agrostis stolonifera	0.9	·	·	·	·	·	·	·	·	·	·	·	·	·	51.7	3.5	·	·	·	4.9	·	·	·	·	·
Galium palustre	·	·	·	·	·	·	·	·	·	·	·	·	·	·	51	·	·	·	·	·	·	·	·	·	·

Veronica beccabunga	·	·	·	·	·	·	·	·	·	·	·	·	·	·	48.5	·	·	·	·	·	·	·	·	·	·
Cuscuta campestris	·	·	·	·	·	·	·	·	·	·	·	·	·	·	48	·	·	·	·	·	·	·	·	·	·
Symphyotrichum squamatum	·	7	·	·	·	·	·	·	·	·	·	·	·	·	45.5	·	·	·	·	15.2	·	·	·	·	·
Setaria parviflora	·	·	·	·	·	·	·	·	·	·	·	·	·	·	45.3	·	·	·	·	·	·	·	·	·	·
Galinsoga quadriradiata	·	·	·	·	·	·	·	·	·	·	·	·	·	·	44.7	·	·	·	·	·	·	·	·	·	·
Setaria faberi	·	·	·	·	·	·	·	·	·	·	·	·	·	·	42	·	·	·	·	·	·	·	·	·	·
Setaria pumila	·	·	·	·	·	·	·	21.3	·	·	·	·	·	·	40.4	·	·	·	·	·	·	·	·	·	·
Salix salviifolia	·	·	·	·	·	·	·	·	·	·	·	·	·	·	38.3	·	·	·	·	·	·	·	·	·	·
Symphyotrichum lanceolatum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	38.3	·	·	·	·	·	·	·	·	·	·
Panicum dichotomiflorum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	38.3	·	·	·	·	·	·	·	·	·	·
Solanum dulcamara	·	·	·	·	·	·	·	·	·	·	·	·	·	·	35.5	·	10.3	·	·	·	1.6	·	·	·	15.4
Mentha aquatica	·	·	·	·	·	·	·	·	·	·	·	·	·	·	34.1	·	·	·	·	·	·	·	·	·	26.6
Rumex obtusifolius	·	·	·	·	·	·	3	·	8.7	·	·	·	·	·	34	11.2	8.5	·	·	·	9.1	·	6.8	·	1.6
Rorippa palustris	·	·	·	·	·	·	·	·	·	·	·	·	·	·	33.5	·	·	·	·	·	·	·	·	·	·
Cladanthus mixtus	·	·	·	·	·	4.1	·	·	·	·	·	3.4	18.7	·	32.6	·	·	·	·	·	·	·	·	·	·
Paspalo-Agrostion semiverticillati																									
Paspalum distichum	·	·	·	·	·	·	·	0.2	·	·	·	·	·	·	19.3	83.4	·	·	·	·	·	·	·	·	·
Schoenoplectus lacustris	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	69.8	·	·	·	·	·	·	·	·	·
Cyperus longus	·	·	·	·	·	·	·	·	·	·	·	6.1	·	·	8.3	66.2	·	·	·	·	·	·	·	·	·
Persicaria lapathifolia	·	·	·	·	·	·	·	0.3	·	·	0.8	·	·	·	24.8	61.8	·	·	·	·	·	·	·	·	1
Xanthium strumarium	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	57.8	·	·	·	·	·	·	·	·	·
Eleocharis palustris	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	54.9	·	·	·	·	·	·	·	·	·
Bidens tripartitus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	8.8	54.4	·	·	·	·	·	·	·	·	·
Juncus articulatus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	49	·	·	·	·	·	·	·	·	·
Rorippa sylvestris	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	48.1	·	·	·	·	·	·	·	·	·
Persicaria decipiens	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	42.6	·	·	·	·	·	·	·	·	·
Alisma lanceolatum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	34.4	·	·	·	·	·	·	·	·	·
Stachys palustris	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	34.1	·	·	·	·	·	·	·	·	·

Veronica anagallis-aquatica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	32.2	.	.	.	.	.	.	.	.	.
Silybo mariani-Urticion piluliferae																									
Silybum marianum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	94	.	.	.	.	.	.	.	.
Carduus tenuiflorus	.	.	.	.	.	.	.	.	.	13.7	.	7.9	.	7.5	.	.	47.3	14.6	.	.	.	.	.	.	.
Anisantha diandra	.	.	.	.	.	.	.	.	10.4	10.4	.	3.7	.	14.6	.	.	43.5	5.3	.	.	1.4	.	6.6	.	.
Carthamus lanatus	.	.	.	.	.	.	.	.	.	.	.	.	.	0.6	.	.	30.2	.	.	.	.	.	.	.	.
Torilis africana	.	.	.	.	.	.	.	.	.	17.8	.	.	.	3.3	.	.	30	7.7	.	.	.	.	0.2	.	.
Carduo carpetani-Cirsion odontolepidis																									
Onopordum acanthium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5.8	85.6	3.4	.	.	.	.	.	.
Reseda luteola	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3.3	48.2	18.1	.	.	.	.	.	.
Lactuca virosa	.	.	.	.	.	.	.	.	.	.	.	.	.	4.4	.	.	9.2	43.3	5.9	11.1	0.6	.	5	.	.
Verbascum pulverulentum	.	.	.	.	.	.	.	.	.	.	3.8	.	.	.	.	.	.	39.7	11.8	8.7	.	.	.	.	.
Dipsacus fullonum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2.6	38.4	18	28.1	1	.	10	.	.
Echium vulgare	.	.	.	.	.	.	.	.	.	.	.	25.4	.	.	.	.	8.6	38.1	17.9	.	.	9.6	.	.	.
Isatis tinctoria	.	.	.	.	.	.	.	.	.	.	.	.	.	1.7	.	.	.	36.7	.	.	.	.	.	.	.
Centaurea langei	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7.8	34.9	3.6	0.7	.	.	.	.	.
Rumex papillaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7.7	34.5	5.4	.	.	.	.	.	.
Melilotus indicus	.	.	.	.	.	.	.	.	.	.	.	.	.	0.5	.	.	.	32.4	.	3.9	.	.	3.4	.	.
Cirsium odontolepis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	31.6	11.5	.	.	.	.	.	.
Cirsion richterano-chodati																									
Cirsium eriophorum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	13.6	68.4	.	.	.	.	.	.
Carduus nutans aggr.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	18.1	52.7	.	1.3	.	.	.	.
Cirsium richterianum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7.7	45.1	.	4.8	.	.	.	.
Cirsium arvense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	28.9	37.3	3.4	.	.	7.3	.	.
Achillea millefolium	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	10.6	37.1	4.4	4.3	12.9	1.9	.	.
Dauco-Melilotion																									
Melilotus albus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4.2	.	.	2.1	.	55.9	.	.	.	.	2.7
Helminthotheca echioides	.	.	.	.	.	.	.	.	0	.	.	19.7	.	1	.	0.8	.	.	.	53.6	.	.	.	.	.

Lotus tenuis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	8.7	·	·	·	45.1	·	·	·	·	·
Hypericum perforatum	·	·	·	·	·	·	·	·	·	2	·	4.1	·	·	·	·	1.7	12.3	·	40.5	·	·	·	·	2.9
Pulicaria dysenterica	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	4.4	·	·	·	37.3	·	·	·	·	28.6
Foeniculum vulgare	·	·	·	·	·	·	·	·	11.2	·	·	25.8	·	·	·	·	10.9	·	·	36.5	·	·	1	·	4.6
Medicago lupulina	·	·	·	0.6	·	·	·	0.9	·	·	·	9.4	·	1	·	·	·	0.7	·	34.3	1.1	·	·	·	·
Erigeron canadensis	10.6	0.1	·	1	·	·	·	2.4	·	·	·	2.7	·	5.7	16.6	·	·	·	·	33.1	·	·	·	·	·
Geo urbani-Alliarion officinalis																									
Anthriscus sylvestris	·	·	·	·	·	·	·	·	·	12.1	·	·	·	·	·	·	·	·	·	·	32.5	·	6	·	·
Arction lappae																									
Oxybasis rubra	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	1.9	81.2	·	·	·
Senecio duriaei	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	77.4	·	5.6	·
Cytisus oromediterraneus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	41.2	·	·	·
Blitum bonus-henricus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	37.5	·	·	·
Barbarea intermedia	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	35.2	·	·	·
Centaurea lagascana	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	34.4	·	·	·
Eryngium bourgatii	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	12.7	·	·	34.2	·	·	·
Arenaria grandiflora	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	31.1	·	·	·
Carum carvi	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	31.1	·	·	·
Balloto-Conion maculati																									
Sambucus ebulus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	1.6	·	·	·	9.8	·	71.5	·	·
Conium maculatum	·	·	·	·	·	·	·	·	·	3.1	·	0	·	2.6	·	·	10	11.5	·	·	4.9	·	35.5	·	·
Epilobion angustifolii																									
Epilobium angustifolium	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	98.1	·
Digitalis purpurea	·	·	·	·	·	·	·	·	·	·	·	1.9	·	·	·	·	·	·	1.5	·	1.5	·	·	69.3	3.8
Avenella flexuosa	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	3.8	·	64.9	·
Luzula lactea	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	63.4	·
Linaria triornithophora	·	·	·	·	·	·	·	·	·	·	·	1.7	·	·	·	·	·	·	·	·	·	·	·	53.2	·
Helictochloa marginata	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	49.3	·

Peucedanum gallicum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	49.3	.
Vaccinium myrtillus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	49.3	.
Eryngium duriaei	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	48.8	.
Hypericum richeri	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2.8	.	46.8	.
Asphodelus albus	.	.	.	.	.	.	.	.	4.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	44.3	.
Anemone nemorosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	40.2	.
Betula celtiberica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	40.2	.
Erica arborea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	39.9	.
Helleborus foetidus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	39.6	.
Lilium martagon	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	39.3	.
Cytisus scoparius	.	.	.	.	.	0.4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	39.1	.
Jacobaea adonidifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.8	.	.	.	.	38.9	.
Silene nutans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.6	.	.	38.7	.
Euphorbia hyberna	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	38.2	.
Genista florida	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4.1	.	37.2	.
Scabiosa columbaria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4.8	.	.	.	35.2	1.8
Neoschischkinia truncatula	.	.	.	0.9	.	2.9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	35	.
Solidago virgaurea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	34.4	8.7
Galium verum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8.5	16.8	.	.	10.4	.	33.8	.
Potentilla sterilis	13.7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1.7	.	.	31.2	.
Scrophularia alpestris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17.8	.	31	.
Senecionion fluviatilis																									
Arundo donax	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	68.7
Angelica sylvestris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3.5	.	3.8	.	55.3
Eupatorium cannabinum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12.1	9.3	.	.	.	.	0	.	.	.	50.7
Pteridium aquilinum	.	.	.	.	.	.	.	.	11.8	.	.	9.9	.	.	.	.	.	.	.	.	2.6	.	2.7	.	45.9
Silene latifolia	.	.	.	.	.	.	.	.	15.7	4.3	.	0.9	.	.	.	.	6.5	.	.	.	.	.	.	.	43
Centaurea debeauxii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10.4	.	.	.	.	34.8

Brachypodium pinnatum aggr.	5.4	·	·	·	·	·	·	·	·	·	·	0.1	·	·	·	·	·	·	·	0.7	0.5	3.4	4.9	·	32.6
Calystegia sepium	·	·	·	·	·	·	·	·	·	·	·	7.9	·	·	28	·	·	·	·	17	1.1	·	13.8	·	31.4
Mentha suaveolens	·	·	·	·	·	·	·	·	0.6	·	·	11.6	·	·	9.9	8.5	19.2	·	·	9.7	3.4	·	0.6	·	30.3
Other common species																									
Cymbalaria muralis	55.7	72.1	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Asplenium trichomanes	48.6	58.2	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Umbilicus rupestris	35.5	35.7	·	·	·	·	·	·	·	13.2	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Asplenium ceterach	51.2	33.9	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Polypodium cambricum	49.5	33.7	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Asplenium ruta-muraria	31.5	33.4	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Parietaria judaica aggr.	64.4	31.3	·	·	·	·	·	·	27.5	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Ochlopoa annua	·	·	20.7	33.4	32.7	2.7	19	·	·	·	11.7	5.9	·	7.5	·	·	·	·	·	·	·	1.3	·	·	·
Lamium maculatum	·	·	·	·	·	·	·	·	30.4	4.6	·	·	·	·	·	·	·	·	·	·	30.5	·	4.6	·	14.5
Galium aparine	·	·	·	·	·	·	·	·	17.1	33	·	1.9	·	0.5	·	·	19.5	·	·	·	28.1	·	32	·	·
Daucus carota	0.6	·	·	·	·	·	·	·	·	·	·	34.8	·	·	·	·	·	8.4	·	51.5	·	·	·	·	7.5
Lythrum salicaria	·	·	·	·	·	·	·	·	·	·	·	·	·	·	73.3	43.8	·	·	·	·	·	·	·	·	·
Lycopus europaeus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	62.6	41.6	·	·	·	·	·	·	·	·	·
Leersia oryzoides	·	·	·	·	·	·	·	·	·	·	·	·	·	·	41.6	30.4	·	·	·	·	·	·	·	·	·
Carduus carpetanus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	53.9	52.5	·	·	·	·	·	·
Jacobaea vulgaris	·	·	·	·	·	·	·	·	·	1.7	·	·	·	·	·	5.2	3.5	32.6	40.7	·	·	·	·	·	·
Picris hieracioides	4.9	·	·	·	·	·	·	·	·	·	·	6.4	·	·	·	·	·	3.1	·	33.4	·	·	·	1.1	37.8
Urtica dioica	·	·	·	·	·	·	·	·	2.6	4.9	·	·	·	0.5	·	·	·	2.5	11.6	·	34.6	30.6	33.9	·	8.2

Alliance	Associatior	Autores
Allion trique	Allio triquet	Alves, Honrado & Barreto de Oliveira 2003
Allion trique	Chelidonio	Amigo & Romero 1997
Allion trique	Urtico mem	A. & O. Bol�s in O. Bol�s & Molinier 1958
Arction lap	Chenopodi	Rivas-Mart�nez 1964
Arction lap	Galactito to	Bellot & Casaseca in Casaseca 1959
Arction lap	Geranio lus	Honrado, Alves, Lomba, Rocha, Torres, Ortiz & Barreto Caldas 2004
Arction lap	Malvo mau	Oberdorfer & T�xen in T�xen & Oberdorfer 1958
Balloto-Cor	Galio aparii	Rivas-Mart�nez ex G. L�pez 1978
Balloto-Cor	Urtico dioic	(Br.-Bl. in Br.-Bl., Gajewski, Wraber & Walas 1936) Br.-Bl. in Br.-Bl., Roussine &
Bidention tr	Bidenti tripa	Rivas-Mart�nez, Belmonte, Fern�ndez-Gonz�lez & S�nchez-Mata in S�nch
Bidention tr	Cypero era	Amigo 2006
Bidention tr	Filaginello	Amigo 2006
Bidention tr	Polygono h	Lohmeyer ex Passarge 1955
Bidention tr	Xanthio ital	O. Bol�s 1957
Carduo car	Carduo car	Rivas-Mart�nez, Penas & T.E. D�az 1986
Chenopodi	Chenopodi	Lohmeyer & Trautmann 1970
Chenopodi	Chenopodi	Carretero 1994
Chenopodi	Sisymbrietu	(Ladero, Socorro, Molero, M.L�pez, Zafra, Mar�n, Hurtado & P�rez-Raya 198
Chenopodi	Urtico uren	(Knapp 1945) Lohmeyer in T�xen 1950
Cirsion rich	Carduo nut	Rivas-Mart�nez & F. Prieto in Penas, T.E. D�az, M.E. Garc�a, L�pez Pache
Cirsion rich	Carduo nut	Loidi 1983
Cirsion rich	Cirsio chod	Rivas-Mart�nez, T.E. D�az, F. Prieto, Loidi & Penas 1984
Cirsion rich	Cirsio chod	Rivas-Mart�nez, T.E. D�az, F. Prieto, Loidi & Penas 1984
Cymbalario	Cymbalarie	G�rs 1966
Cymbalario	Cymbalario	Rivas-Mart�nez 1969
Senecionio	Picrido hier	Loidi & C. Navarro 1988
Dauco-Meli	Helminthio	Loidi & C. Navarro 1988
Dauco-Meli	Echio rosul	P. Alves & J. Honrado
Echio-Gala	Coleosteph	Izco & Collado 1985
Epilobion a	Asphodelo	Izco, J. Guiti�n & Amigo 1986 corr. Izco & Amigo 2001
Galio valan	Centrantho	Rivas-Mart�nez 1969
Galio valan	Hedero-Pol	Loriente Escallada 1985
Galio valan	Parietarietu	K. Buchwald 1952
Geo urbani	Geranio rob	Izco, J. Guiti�n & Amigo 1986
Geo urbani	Geranietum	Loidi, Berastegi, Biurrun, Garc�a-Mijangos & Herrera 1995
Geo urbani	Oxalido ace	Loidi, Berastegi, Biurrun, Garc�a Mijangos & Herrera 1996
Geranio pu	Anthrisco c	O. Bol�s & Vigo in O. Bol�s 1967
Geranio pu	Galio aparii	Rivas-Mart�nez 1978
Linario poly	Scrophulari	Br.-Bl., Rozeira & P. Silva in Br.-Bl., G. Br.-Bl., Rozeira & P. Silva 1972
Oxalidion e	Fumario ca	Aedo, Herrera, F. Prieto & T.E. D�az 1988
Oxalidion e	Holosteo ui	Penas, T.E. D�az, C. P�rez, Puente, M.E. Garc�a & Terr�n 1988
Oxalidion e	Lamio amp	Aedo, Herrera, F. Prieto & T.E. D�az 1988
Paspalo-Ag	Paspalo dis	Br.-Bl. in Br.-Bl., Gajewski, Wraber & Walas 1936
Polycarpior	Crassulo til	Rivas-Mart�nez 1975
Polycarpior	Polycarpo t	Wildpret, P�rez de Paz, Del Arco & Garc�a Gallo 1988
Polycarpior	Poo annua	Herrera, Aedo, T.E.D�az & F. Prieto 1988
Polygono-C	Coronopod	Br.-Bl. in Br.-Bl., Gajewski, Wraber & Walas 1936
Polygono-C	Matricario-l	M�ller ex Oberdorfer 1971 corr. Passarge 1996
Polygono-C	Polycarpo t	Rivas-Mart�nez, Wildpret, Del Arco, O. Rodr�guez, P�rez de Paz, Garc�a G
Saginion pr	Sagino-Bry	Diemont, Sissingh & Westhoff 1940
Scleranthio	Bunio eruca	Rivas-Mart�nez, Izco & Costa 1971
Scleranthio	Catapodieti	Br.-Bl., P. Silva, Rozeira & Fontes 1952
Scleranthio	Centaureo	Penas, T.E. D�az, P. Morales, Puente, M.E. Garc�a & Terr�n 1988
Scleranthio	Chrysanthe	Bellot 1951
Scleranthio	Linario ame	Izco 1982

Scleranthio	Linario delp	Bellot & Casaseca in Casaseca 1959
Scleranthio	Linario eleg	T�xen & Oberdorfer 1958
Scleranthio	Miboro min	Rivas-Mart�nez & C. Rivas-Mart�nez 1970
Scleranthio	Spergularic	Rivas-Mart�nez & C. Rivas-Mart�nez 1970
Senecionio	Arundini do	T�xen & Oberdorfer ex O. Bol�s 1962
Senecionio	Solano dulc	Biurrun, Garc�a-Mijangos, Benito Crespo & Fern�ndez-Gonz�lez 2008
Silybo mari	Carduo bou	Rivas-Mart�nez ex Rivas-Mart�nez, Costa & Loidi 1992
Silybo mari	Echio rosul	Pulgar, Ortiz & Rodr�guez-Oubi�a in�d.
Sisymbrion	Bromo diar	Ortiz in�d.
Sisymbrion	Hordeetum	Libbert 1933
Sisymbrion	Sisymbrio c	Br.-Bl. 1967
Spergulo a	Amarantho	T�xen & Oberdofer 1958
Spergulo a	Lamio diss	T�xen & Oberdorfer 1958
Spergulo a	Setario ver	Bartolom� & Mart�nez-Parras 1985

: N�gre 1952
hez-Mata 1989

81) Rivas-Mart�nez & Ladero ass. nova (addenda)

eco, Puente & L. Herrero 1988

Gallo, Acebes, T.E. D�az & Fern�ndez-Gonz�lez 1993

Classification and characterization of anthropogenic plant communities ~~at~~in the ~~ecoregion level~~northwestern Iberian Peninsula

Abstract (300 words max.)

- *Questions* ~~How can~~Can we ~~classify the diversity~~reconcile regional and European classifications of anthropogenic plant communities at the ~~ecoregion level?~~biogeographical scale? How are these communities characterized by species origins~~ (native plants, archaeophytes, and neophytes), species~~, traits ~~(lifeforms, plant height, and flowering phenology)~~ and ecological preferences~~ (temperature, moisture, light, nutrients, soil reaction, disturbance frequency, and disturbance severity)?~~?
- *Location* ~~Iberian~~ Atlantic ~~ecoregion~~territories in the NW Iberian Peninsula (a.k.a. Cantabrian Mixed Forests~~); Portugal, Spain, and France;~~ ecoregion); south-western Europe.
- *Methods* We ~~compiled a vegetation database of~~ classified 2,508 ~~synanthropic~~ plots ~~and revised~~with the aim of being consistent with regional ~~checklist of anthropogenic vegetation~~phytosociological expertise, while matching that expertise with current EuroVegChecklist alliances. We used modified TWINSPAN ~~and~~to revise the original phytosociological classification, followed by semi-supervised re-classification ~~to classify the plots into~~of the ~~revised alliances.~~whole dataset. We determined the proportion of natives, archaeophytes~~,~~ and neophytes. We also described the alliances

in terms of species traits (lifeforms, height and flowering phenology) and ecological requirements~~.~~ (temperature, moisture, light, nutrients, soil reaction, disturbance frequency and severity).

- *Results* We ~~classified~~assigned 2,~~081~~086 vegetation plots ~~into 28~~to 25 anthropogenic alliances representing 9 vegetation classes (*Cymbalario-Parietarietea diffusae*, *Polygono-Poetea annuae*, *Papaveretea rhoeadis*, *Digitario sanguinalis-Eragrostietea minoris*, *Chenopodietea*, *Sisymbrietea*, *Bidentetea*, *Artemisietea vulgaris* and *Epilobietea angustifolii*). The plots included 1,~~162 plant~~149 taxa: 78% natives, 15% archaeophytes~~,~~ and 7% neophytes. Vegetation groups were organized along a principal axis of ~~variation related to~~ abiotic stress (dry-sunny to moist-shady habitats~~),~~) and a ~~second~~secondary axis ~~related to~~of disturbance~~ (low to high disturbance frequency and severity).~~.

- *Conclusions* ~~Ecoregion-level synthesis detected a discrepancy between the number of anthropogenic vegetation units described in the literature (38 alliances) and the number supported by numerical classification (28). The diversity of anthropogenic vegetation can be organized into three groups: trampled, weeds, and ruderals.~~ In the Iberian Atlantic ~~ecoregion~~territories, anthropogenic habitats host one third of the ~~ecoregion~~regional plant species pool and one fifth of the Iberian flora. Mesic perennial ruderal vegetation is especially rich in native species and can be a biodiversity asset in urban ~~ecosystems~~landscapes. Our ~~ecoregion~~biogeographical-level ~~framework~~synthesis can improve the ~~assessment and~~ management of anthropogenic plant communities ~~within biogeographically meaningful regions~~and contribute towards a European-level synthesis of human-made vegetation.

Keywords (10 max)

Synanthropic vegetation, manmade habitats, human-made habitats, urban biodiversity, neophytes, archaeophytes, alien plants, habitat classification, semi-supervised classification, ~~Iberian Atlantic ecoregion~~Cantabrian Mixed Forests

Introduction

Anthropogenic vegetation ~~consists~~is the sum of plant communities assembled as a direct consequence of human activities. In general, this vegetation is composed of the so-called weeds of arable fields and the ruderal plants ~~of~~growing on human settlements and nearby habitats (Lososová & Simonova 2008). ~~Anthropogenic communities make up an important part of the supply of biodiversity in urban and peri-urban areas ().~~ In densely populated landscapes, the ~~plant~~anthropogenic communities that colonize ~~urban~~ vacant lots (Johnson et al. 2017) are a useful natural resource with high ecological and societal potential (Anderson & Minor 2017; Kowarik 2018). Anthropogenic vegetation can also mitigate regional-level extreme climatic events (Stefanon et al. 2014). Furthermore, many synanthropic plants are adapted to disturbance and can accumulate heavy metals in their biomass (Kostryukova et al. 2017), making them valuable candidates for nature-based solutions such as bioremediation and restoration of degraded post-industrial landscapes (Song et al. 2019).

In temperate Europe, anthropogenic vegetation is a melting pot of floras from different biogeographical origins. ~~Starting with a~~ The starting native pool of ~~native~~ species favored by humans~~, and~~ has been constantly enriched by human-assisted arrival of alien (i.e. non-native) species (Pokorná et al. 2018). The introduction of archaeophytes (i.e. alien species arriving before 1.500 CE) likely started in the early Neolithic and peaked in the Bronze Age, with successive waves during periods of accelerated human colonization such as the early Middle Ages (Pokorná et al. 2018). In Europe, synanthropic archaeophytes include many Mediterranean taxa originating from the segetal flora of the Near East (Zohary 1950). Some of these archaeophytes are 'obligate weeds' that do not occur in non-anthropogenic habitats and are assumed to have evolved together with human agriculture (Zohary 1950). ~~Since many archaeophytes started their expansion into temperate areas during the Mid-Holocene warm period, it is difficult to disentangle to what extent this expansion was favored by human activities and/or ongoing climatic changes (;).~~ The synanthropic flora of Europe has been further enriched by neophytes, alien taxa that arrived after the expansion of intercontinental trade in the Modern Age (after 1.500 CE) (Brun 2009). Synanthropic neophytes therefore include many American, African~~,~~ and Asian taxa that arrived in Europe because of the global trade networks established by western European colonialism (Lenzner et al. 2022). In the last century, the European anthropogenic vegetation has shown a decrease in species richness and diversity (Pyšek et al. 2004), as rare synanthropic species have become rarer~~,~~ and neophytes have increased their abundance at the expense of natives and archaeophytes (Lososová & Simonova 2008).

Despite the potential of anthropogenic vegetation as a biodiversity asset in human-made landscapes~~,~~ and its ecological interest as an assemblage of species pools from different biogeographical origins, human-made vegetation is largely absent from ecosystem management. A comprehensive management will require a solid definition, classification~~,~~ and description of anthropogenic plant communities. However, the classification of anthropogenic vegetation is subject to particularities making it a special case compared to the classification of non-anthropogenic communities. In human-made habitats, the traditional understanding of community assembly based on sequential filtering (dispersal, abiotic~~,~~ and biotic) must incorporate an additional filtering based on human preferences and actions (Swan et al. 2021). Human landscapes are a mosaic of land uses (Pauleit & Breuste 2011), having specific effects on plant community assembly~~,~~ and driven by sociological rather than traditional ecological factors (Johnson et al. 2017~~). In addition to these potentially confounding factors, human-assisted dispersal means that anthropogenic floras are relatively homogeneous across large biogeographical scales. However, traditional phytosociology has tended to classify them with a level of detail similar to the one dedicated to non-anthropogenic vegetation, leading to an inflation of anthropogenic syntaxa ().~~). Another issue is defining anthropogenic vegetation, especially in a continent such as Europe where human impact on the landscape has been widespread since ancient times. The two major vegetation/habitat classifications coexisting in Europe today, phytosociological classification (Mucina et al. 2016) and the EUNIS habitat classification (Chytrý et al. 2020), have ~~non-overlapping~~not fully equivalent definitions of which plant communities fall within ~~the~~their 'anthropogenic' or 'manmade' categories. These issues are further muddled by the fact that most classification studies of anthropogenic vegetation have focused either on a restricted political unit (Nemec et al. 2011; Tabasevic, Jovanovic, et al. 2021) or in a subset of the vegetation, such as segetal (Zohary 1950), ruderal (Zaliberova 1995) or trampled (Golovanov et al. 2023) vegetation. There is a need for a numerical classification and synthesis of the full spectrum of anthropogenic vegetation, ~~and an appropriate scale to conduct such study is the ecological region (ecoregion, hereafter), since these~~focusing on coherent biogeographical units~~ are assumed to encompass ~~, i.e. areas with a similar bioclimate, a shared biogeographic history and recurrent local ecosystems (Bailey 2004).

The ~~Iberian ~~Atlantic ~~ecoregion~~territories in the NW Iberian Peninsula (a.k.a. Cantabrian Mixed Forests ecoregion~~; NW Iberian Peninsula) has~~) have a long history of human habitation dating back to the Cantabrian Upper Paleolithic (Straus 2005). This, together with ~~its~~their transitional position at the border between the temperate and Mediterranean climatic zones of Europe~~ ()~~, suggests a long regional history for archaeophyte-rich anthropogenic plant communities, supporting the current diverse anthropogenic vegetation with both temperate and Mediterranean floristic elements (Díaz González 2020). Moreover, historical trade links with America and Asia, together with the warm and humid temperate climate, have made the region a hotspot for biological invasions (Fernández de Castro et al. 2018; Lázaro-Lobo et al. 2024). Recent post-industrial land-use changes have left large areas with abandoned industrial sites (i.e. brownfields) whose management and restoration requires an understanding of the anthropogenic communities able to colonize them (Gallego et al. 2016; Matanzas et al. 2021). Although there is a long tradition of studying weed and ruderal communities ~~in~~within the ~~ecoregion~~area (Aedo et al. 1988; Díaz González et al. 1988; Loidi & Navarro Aranda 1988; Penas, Díaz González, García González, et al. 1988; Penas, Díaz

González, Pérez Morales, et al. 1988; Loidi et al. 1995; Loidi et al. 1996) there is a current need for ~~an ecoregion~~a biogeographical-level synthesis that revises and updates the classification in accord with recent developments in European vegetation science (Mucina et al. 2016) and habitat classification (Chytrý et al. 2020). In this article, we have performed such a synthesis with the following two objectives: (1) to provide an updated classification at the alliance level of anthropogenic plant communities in the Iberian Atlantic ~~ecoregion~~territories; and (2) to characterize the diversity of anthropogenic vegetation in terms of species pools (natives, archaeophytes, neophytes); species traits (life form, plant height, flowering phenology); and ecological requirements (temperature, moisture, light, nutrients, soil reaction, disturbance frequency~~,~~ and disturbance severity).

Methods

Data curation and taxonomic criteria

We performed all data management and analysis with R version 4.3.1 (R Core Team 2023), using the R package *tidyverse* (Wickham et al. 2019) for data processing and visualization. We homogenized all taxon names using Euro+Med (Euro+Med 2006) or Plants of the World Online (POWO 2023) for taxa not in Euro+Med. For the nomenclature of syntaxa, we followed Mucina *et al.* (2016) for alliances and higher ranks~~,~~ and Rivas-Martínez *et al.* (2001) for associations. The original datasets, as well as R code for analysis and creation of the manuscript, are stored in a GitHub repository available at Zenodo (see 'Data availability statement').

~~*Study ecoregion*~~

Biogeographical territory under study

We studied the anthropogenic plant communities of the Iberian Atlantic ~~ecoregion~~territories, a biogeographical unit defined by Fernández Prieto *et al.* (2020; 2023~~), i.e.~~) as the territories with a temperate climate in the north-western part of the Iberian Peninsula (NW Portugal, N Spain, SW France). Our study area follows the detailed borders provided by Fernández Prieto *et al.* (2020; 2023~~ecoregion~~) and is broadly ~~corresponds~~equivalent to the Cantabrian Mixed Forests ecoregion *sensu* Olson *et al.* (2001), to the Iberian part of the European Atlantic province *sensu* Rivas-Martínez *et al.* (2014; 2017~~(~~)) (i.e. the Orocantabrian subprovince and parts of the Cantabro Atlantic subprovince) and to the Iberian section of the Atlantic biogeographical region of the European Environmental Agency (https://www.eea.europa.eu/data-and-maps/figures/biogeographical-regions-in-europe-2).

Definition of anthropogenic vegetation

To circumscribe our study vegetation, we followed the definition of anthropogenic vegetation in the revised classification of the vegetation of Europe by Mucina *et al.* (2016). In our study area, this potentially includes the vegetation classes *Polygono-Poetea annuae*, *Papaveretea rhoeadis*, *Digitario sanguinalis-Eragrostietea minoris*, *Chenopodietea*, *Sisymbrietea*, *Bidentetea*, *Artemisietea vulgaris*~~,~~ and *Epilobietea angustifolii*. For the sake of completeness, we also considered the class *Cymbalario-Parietarietea diffusae* included by Mucina *et al.* (2016) in the vegetation of rock crevices and screes, since this class encompasses the vegetation of human-made walls.

Checklist of anthropogenic syntaxa

To assist in our classification, we prepared a checklist of anthropogenic syntaxa that could be present in our study ~~ecoregion~~area (**Appendix S1**), based on regional syntaxonomical checklists (Izco et al. 2000; Díaz González 2020; Durán Gómez 2020) and recent revisions at the European level (Mucina et al. 2016; Preislerová et al. 2022). This syntaxonomical checklist included ~~38~~34 anthropogenic vegetation alliances that could be present in the Iberian Atlantic ~~ecoregion~~territories according to the literature.

Vegetation data selection

We retrieved Iberian Atlantic anthropogenic vegetation plots from the Iberian and Macaronesian Vegetation Information System (SIVIM) (Font et al. 2012). To identify plots as anthropogenic, we selected those plots that had been assigned by the original authors of the plot into any anthropogenic syntaxa in our syntaxonomical checklist. However, since not all plots in SIVIM have an assigned syntaxon, we also retrieved additional plots using the expert system created by Chytrý *et al.* (2020) to classify vegetation plots into EUNIS pan-European habitat types. We retrieved plots that had been assigned to any habitat related to the anthropogenic vegetation classes we had previously defined: all habitats in the level 1 code *V Vegetated man-made habitats*, plus level 3 codes *R55 Lowland moist or wet tall-herb and fern fringe* and *R57 Herbaceous forest clearing vegetation*. It must be noted that habitats *R55* and *R57* include communities that are classified as *R Grasslands and lands dominated by forbs, mosses or lichens* by EUNIS but as *Anthropogenic vegetation* by Mucina *et al.* (2016). The extraction of data from SIVIM produced an initial pool of 3,160 vegetation plots, to which we added 89 vegetation plots of urban or peri-urban plant communities sampled by us or extracted from local literature not included in SIVIM (Zabaleta Mendizábal 1990; Uría Arizaga 2020).

Vegetation data cleaning

We performed an exploratory data analysis of these 3,249 plots using modified Two-Way Indicator Species Analysis (TWINSPAN) (Roleček et al. 2009) with the R package *twinspanR* (Zelený 2021~~),~~). We used 3 pseudospecies cut levels (0, 15, 25), a minimum group size of 10 plots~~,~~ and Sørensen's average dissimilarity. During this analysis we identified 741 outlier plots which did not belong to either the target anthropogenic vegetation or to the geographical area of the ~~ecoregion.~~Iberian Atlantic territories. The majority of these plots corresponded to coastal plant communities and had been misclassified by the expert system. We removed these plots, ~~leaving~~resulting in a dataset of 2,508 vegetation plots for data analysis: 2,419 plots from SIVIM, originally recorded in 89 publications (**Appendix S2**); plus 89 plots added by us.

Training dataset for semi-supervised classification and validation of alliances

~~To create a training dataset for the semi-supervised~~ The main aim of our classification was for it to be consistent with regional phytosociological expertise and to match that expertise with current EuroVegChecklist alliances (Mucina et al. 2016). To achieve this, one advantage of using the SIVIM database is that a majority of the plots had been assigned to associations or alliances by the original authors (Font et al. 2012~~(see below),~~). However, there could be misclassification due to unclear concepts or human error. Therefore, we used TWINSPAN to revise the classification by the original authors, to define the number of clusters that better aligned with our syntaxonomical checklist and to remove outliers or misclassified plots.

We started this stage of the analyses by keeping only those plots (n = 2,~~201~~095) that had been assigned by the original authors of the plot to any of the ~~38~~9 anthropogenic ~~alliances~~ vegetation classes defined in our syntaxonomical checklist (i.e., we removed the plots without syntaxa, that had been retrieved solely by the expert system). ~~We further cleaned this subset using a preliminary TWINSPAN classification, in which~~ Then, we ~~attempted to match the~~ performed a TWINSPAN classification (with the same settings as above) within each vegetation class, attempting to classify its plots into ~~the 38 alliances.~~ a number of clusters equal to the number of alliances of that class in our checklist. We assigned the resulting clusters to an alliance in our checklist based on their composition of diagnostic species as described in the regional literature. In some cases, this resulted in a classification into a number of clusters in which (1) more than one cluster was assigned to the same alliance in the checklist; and (2) some alliances in the checklist could not be assigned to any of the clusters (i.e. the plots that had been assigned by the original authors to that alliance were separated in different clusters). By the end of this process, of the 34 alliances in our checklist, 25 had been assigned to clusters. Nine alliances were not assigned to any cluster. Of these, eight had been assigned to a few plots by the original authors: *Onopordion castellani* (n = 6 plots), *Onopordion acanthii* (5), *Euphorbion prostratae* (4), *Caucalidion lappulae* (4), *Roemerion hybridae* (2), *Hordeion murini* (2), *Taeniathero-Aegilopion geniculatae* (1) and *Fragarion vescae* (1). The alliance *Aegopodion podagrariae* had been assigned by the original authors to 39 plots, but our TWINSPAN analysis could not separate this alliance from the alliances *Geo urbani-Alliarion officinalis* and *Balloto-Conion maculati*.

This ~~step~~stage of the analyses allowed us to identify those plots in which there was an agreement between (1) our TWINSPAN-based classification (i.e. numerical classification) and (2) the classification based on the original author's syntaxon~~.~~ (i.e. regional phytosociological expertise). These plots (n = 1,~~725)~~850) were the best representatives of each alliance and became our training dataset for semi-supervised classification. ~~Furthermore, this step allowed us to validate which alliances from our syntaxonomical checklist were present in the study ecoregion (n = 28) and which were absent (n = 10).~~

Semi-supervised classification

Next, we conducted a semi-supervised classification (Tichý et al. 2014) of the whole dataset (n = 2,508 plots) into the ~~28~~ 25 TWINSPAN-validated anthropogenic alliances. Semi-supervised classification uses a training subset of *a priori* classified vegetation plots to classify a secondary subset of unclassified plots (De Cáceres et al. 2010). Since our goal was to refine the classification of the whole dataset, we allowed plots from the training subset to be re-assigned to other alliances during the re-classification. In addition, semi-supervised classification can create new groups to place data points that do not match the already existing *a priori* groups, but attempts to do so resulted in new groups with no ecological significance~~,~~ and thus we kept the ~~28~~25 alliances as final anthropogenic vegetation groups. Furthermore, we applied a noise clustering fuzzy algorithm, which allows plots to be classified either into the *a priori* alliances or into a *noise* group which includes outliers and transitional plots (Wiser & De Cáceres 2013). We set the fuzziness coefficient to a low value (m = 1) to accommodate a high number of transitional plots; and we set the distance to the noise class to d = 1. We performed this analysis with the R package *vegclust* (De Cáceres et al. 2010). The semi-supervised classification with noise clustering resulted in the final classification of 2,~~081~~086 plots into ~~28~~26 alliances and ~~427~~422 plots left out in the noise group. We used pairwise PERMANOVA (with 100,000 iterations, Euclidean distances~~,~~ and Holm's p-value correction) fitted with the R package *RVAideMemoire* (Herve 2023) to test the significance of the final vegetation alliances; along with Principal Component Analysis (PCA) as implemented in the R package *FactoMineR* (Lê et al. 2008) to visualize the relationships between the classes and alliances.

Characteristic species and EUNIS habitat correspondence

To facilitate the use of the classification by local managers and environmental consultants, we calculated sets of characteristic species ~~**(Appendix S3)**~~ (Chytrý et al. 2020) for each one of the final ~~28~~25 vegetation alliances. We defined dominant species as species with more than 25% cover in at least 5% of the vegetation plots of the group; constant species as species with a frequency higher than 50% in the group; and diagnostic species as species whose *IndVal* had a p-value lower than 0.05, as calculated with the R package *labdsv* (Roberts 2016) using 1.000.000 iterations. Additionally, we assigned to each alliance ~~its corresponding~~a regionalized level~~-3~~ 4 EUNIS habitat code~~ or codes~~ (https://eunis.eea.europa.eu/habitats-code-browser-revised.jsp).

Species origin as native, archaeophyte~~,~~ or neophyte

We classified the species as native, archaeophytes~~,~~ or neophytes in the Iberian Atlantic ~~ecoregion~~territories using the information in *Flora iberica* (1987-2020) and catalogues of archaeophytes for Britain (Preston et al. 2004) and the Czech Republic (Chytrý et al. 2021). We must stress that identifying archaeophytes in southern Europe is highly problematic (Celesti-Grapow et al. 2009) and our classification must be taken as an indication of putative archaeophyte character for the purposes of vegetation description and comparison with other European regions, rather than a definitive classification of the species; as stated by Preston *et al.* (Preston et al. 2004), the classification of a species as an archaeophyte should be interpreted as a hypothesis to be tested by further studies.

Species life form

Using *FloraVeg.EU* (2023) we extracted the species' life forms and kept *therophyte* and *geophyte* for further analysis since these two categories had the largest contribution to variance among alliances, as per an exploratory Principal Component Analysis (PCA) performed using the R package *FactoMineR* (Lê et al. 2008).

Species height and flowering phenology

From *Flora iberica* (1987-2020) we extracted the maximum height, median month of flowering~~,~~ and length of the flowering period of each species in the dataset. We used these variables to calculate plot-level community-weighted means (weighting by species cover) for each trait, to characterize the vegetation height and flowering phenology of the anthropogenic plant communities.

Species ecological indicator values

For each species in the dataset, we collected its ecological indicator values of temperature, moisture, light, nutrients~~,~~ and soil reaction (Dengler et al. 2023); and its disturbance frequency and severity indicator values (Midolo et al. 2023). To those species lacking an indicator value in the accessed references, we assigned a value by reciprocal averaging, i.e. by (1) calculating weighted average values of the species with values for each plot (weighting by species cover~~),~~) and (2) assigning to the missing species the weighted average values of the plots where they were present (weighting by species cover). Then, for each vegetation plot, we calculated the plot-level mean of each indicator value.

Results

Overview of the classification

The semi-supervised classification resulted in the classification of 2,~~081~~086 vegetation plots into ~~28~~25 anthropogenic alliances (**Fig. 1**, description of the alliances and correspondence with EUNIS habitat types in **Appendix S3**, groups of characteristic species in **Appendix S4**, synoptic table in **Appendix S5**) representing 9 vegetation classes. ~~Most of the alliances had a wide distribution in the ecoregion according to our dataset, but five of them (*Caucalidion lappulae*, *Linario polygalifoliae-Vulpion alopecuri*, *Convolvulo arvensis-Agropyrion repentis*, *Senecionion fluviatilis* and *Paspalo-Agrostion semiverticillati*) had isolated occurrences towards the southern limit of the Iberian Atlantic territories.~~ The regional literature included in our dataset recognized ~~72~~69 associations (**Appendix ~~S5~~S6**) within these alliances, but exploratory analysis (not shown) indicated that the separation of these associations within the alliances had a generally weak support based on numerical classification methods.

The classified plots included 1,~~162~~149 taxa or taxa aggregates. The 10 most frequent species were *Ochlopoa annua* (~~621~~625 occurrences), *Urtica dioica* (~~592~~588), *Sonchus oleraceus* (~~540~~548), *Stellaria media* (~~516~~520), *Capsella bursa-pastoris* (~~390~~396), *Polygonum aviculare* (~~375~~373), *Dactylis glomerata* (~~363~~369), *Senecio vulgaris* (~~332),~~336) and *Anisantha sterilis* (~~301~~310). Considering only those plots with the most frequent plot size range (10-30 m^2, n = 867 plots), the average species richness per plot was 16 (minimum = 3, maximum = 48). The class with the richest species pool was *Epilobietea angustifolii* (n = ~~615~~605) and the poorest was ~~*Cymbalario-Parietarietea diffusae*~~*Bidentetea* (n = ~~171~~132).

PCA ordination of the floristic composition (**Fig. 2A**) ~~clearly~~ differentiated three vegetation groups: (1) trampled vegetation of class *Polygono-Poetea annuae*; (2) crop weeds of classes *Papaveretea rhoeadis* and *Digitario sanguinalis-Eragrostietea minoris*; and (3) perennial ruderal vegetation of classes *Artemisietea vulgaris* and *Epilobietea angustifolii*. The central position of the floristic space, between these three major groups, was occupied by the annual ruderal vegetation of classes *Chenopodietea*, *Sisymbrietea*~~,~~ and *Bidentetea*; as well as by the wall vegetation of class *Cymbalario-Parietarietea diffusae*. Separate PCAs within the major vegetation groups indicated a coherent separation between most of the alliances, but with some cases of relatively high overlap~~: for example,~~, especially between ~~(i)~~ *Galio valantiae-Parietarion judaicae* and *Cymbalario-Asplenion*~~; or (ii) *Geo urbani-Alliarion officinalis* and *Aegopodion podagrariae*~~.

Proportion of natives, archaeophytes and neophytes

The total synanthropic species pool (n = 1,~~162~~149) was composed of 78% natives (n = ~~908~~899), 15% putative archaeophytes (n = ~~178),~~174) and 7% neophytes (n = 76). The most frequent putative archaeophytes were *Capsella bursa-pastoris* (~~390~~396 occurrences), *Senecio vulgaris* (~~332~~336), *Anisantha sterilis* (~~301~~310), *Hordeum murinum* (297), *Anthemis arvensis* (~~280), *Hordeum murinum* (274~~290), *Raphanus raphanistrum* (~~233~~236), *Vicia sativa* (~~228~~229), *Malva sylvestris* (~~197~~210), *Sisymbrium officinale* (~~166),~~185) and ~~*Echinochloa crus-galli* (165~~*Anisantha diandra* (175); while the most frequent neophytes were *Veronica persica* (~~212~~215), *Erigeron canadensis* (~~138~~136), *Amaranthus hybridus* (~~73~~75), *Oxalis corniculata* (~~67~~66), *Lepidium didymum* (~~57~~59), *Oxalis latifolia* (~~51~~56), *Paspalum distichum* (~~48~~42), *Bidens frondosus* (~~35~~34), *Cyperus eragrostis* (34~~),~~,) and *Symphyotrichum squamatum* (~~33~~34).

By vegetation class, *Epilobietea angustifolii* had the highest proportion of natives in its species pool (82%); *Sisymbrietea* had the highest proportion of putative archaeophytes (~~31~~30%); and *Bidentetea* had the highest proportion of neophytes (~~17~~16%). The alliances with the highest proportions of archaeophytes in their species pools were ~~*Caucalidion lappulae* (41%),~~ *Chenopodion muralis* (35%%), *Silybo mariani-Urticion piluliferae* (31%) and *Sisymbrion officinalis* (~~31~~30%); while the alliances with the highest proportion of neophytes were *Bidention tripartitae* (~~19~~20%), *Allion triquetri* (12~~%),~~%) and *Spergulo arvensis-Erodion cicutariae* (~~10~~11%).

At the community level, focusing on plot average proportions (**Fig. 3**), the alliances with the most archaeophytes were ~~*Caucalidion lappulae*,~~ *Sisymbrion officinalis*, *Silybo mariani-Urticion piluliferae* and *Spergulo arvensis-Erodion cicutariae*~~, and *Sisymbrion officinalis*~~, in which only about half of the plot-level proportion was made up of native species. The alliances with the highest plot-level proportion of neophytes were *Bidention tripartitae*, *Paspalo-Agrostion semiverticillati*~~,~~ and ~~*Senecionion fluviatilis*.~~*Spergulo arvensis-Erodion cicutariae*. Some alliances had high proportions of native species, e.g. *Epilobion angustifolii*, ~~*Convolvulo arvensis-Agropyrion repentis*, and~~ *Linario polygalifoliae-Vulpion alopecuri* and *Arction lappae*.

Community-level traits

The most frequent life form in the species pool (n = 1,~~162~~149 species) were hemicryptophytes (44%), followed by therophytes (~~42~~41%), geophytes (~~9~~8%), chamaephytes (6%), phanerophytes (~~6~~5%), bryophytes (1~~%),~~%) and hydrophytes (1%). The proportion of therophytes across classes and alliances (**Fig. 4**) agreed with the traditional description of the syntaxa: therophytes dominated the annual communities of trampled-soil vegetation (*Polygono-Poetea annuae*), crops weeds (*Papaveretea rhoeadis*, *Digitario sanguinalis-Eragrostietea minoris*~~),~~) and annual ruderals (*Chenopodietea*, *Sisymbrietea*, *Bidentetea*); while perennial life forms (especially hemicryptophytes) dominated walls (*Cymbalario-Parietarietea diffusae*) and perennial ruderal vegetation (*Artemisietea vulgaris*, *Epilobietea angustifolii*). Geophytes represented a relatively high proportion of the vegetation in ~~three~~two alliances: *Allion triquetri*~~, *Convolvulo arvensis-Agropyrion repentis*,~~ and *Senecionion fluviatilis*.

Community-weighted means for plant height (**Fig. 5A**) also agreed with the expected description of the syntaxa: the shortest communities were the dwarf-herb vegetation of trampled sites (*Polygono-Poetea annuae*, average height = 45.2 cm) and crop weeds

(*Papaveretea rhoeadis*, 55.~~4~~6 cm), while the tallest were the perennial ruderal vegetation of dry (*Artemisietea vulgaris*, ~~129~~131 cm) and mesic (*Epilobietea angustifolii*, ~~136~~138 cm) sites. The median month of flowering (**Fig. 5B**) corresponded to May (*Sisymbrietea*, *Chenopodietea*, *Papaveretea rhoeadis*), June (*Cymbalario-Parietarietea diffusae*, *Polygono-Poetea annuae*, *Epilobietea angustifolii*, *Artemisietea vulgaris*) or July (*Digitario sanguinalis-Eragrostietea minoris*, *Bidentetea*). The length of the flowering season (**Fig. 5C**) was generally high, from 5 months (*Artemisietea vulgaris*, *Epilobietea angustifolii*) to 6 (*Chenopodietea*, *Sisymbrietea*), 7 (*Bidentetea*, *Digitario sanguinalis-Eragrostietea minoris*, *Papaveretea rhoeadis*), 8 (*Polygono-Poetea annuae*~~),~~) or 9 (*Cymbalario-Parietarietea diffusae*).

Community-level ecological preferences

To visualize the major patterns of variation in the ecological and disturbance preferences of the different anthropogenic communities (**Fig. 6**) we performed a PCA ordination of plot-level means (**Fig. 7**). The first two PCA axes explained 59% of the ~~variability~~variance. The major contributors to axis 1 (36% variance explained) were light, nutrient~~,~~ and moisture requirements; it separated communities of open, dry and comparatively nutrient-poorer sites (classes *Papaveretea rhoeadis*, *Polygono-Poetea annuae*, *Sisymbrietea*, *Artemisietea vulgaris*, *Chenopodietea*~~,~~ and *Digitario sanguinalis-Eragrostietea minoris*) from communities of shady, moist and nutrient-richer sites (classes ~~*Cymbalario-Parietarietea diffusae*, ~~*Bidentetea*~~,~~ and *Epilobietea angustifolii*). The major contributors to axis 2 (23% variance explained) were disturbance severity and frequency; this axis separated communities preferring less severe and less frequent disturbances (classes *Cymbalario-*

Parietarietea diffusae, *Epilobietea angustifolii*~~, *Chenopodietea*, *Artemisietea vulgaris* and *Bidentetea*~~) from communities adapted to more severe and more frequent disturbances (classes *Papaveretea rhoeadis*, *Polygono-Poetea annuae*, *Sisymbrietea* and *Digitario sanguinalis-Eragrostietea minoris*).

Discussion

Our synthesis of the anthropogenic vegetation ~~at~~of the ~~ecoregion level~~northwestern Iberian Peninsula has detected a discrepancy between the number of vegetation units described in the literature (i.e. ~~38~~34 alliances) and the number supported by numerical classification (~~28~~25 alliances). Our classification supported that anthropogenic vegetation can be broadly divided into three groups belonging to trampled, weed~~,~~ and ruderal communities. These groups are organized along a principal axis of variation related to abiotic stress~~,~~ and a second axis related to disturbance. These two axes determine the characteristics of the communities in terms of species origins and species traits. This synthesis allows for a better understanding of anthropogenic vegetation, as a first step towards a better integration of this biodiversity asset into ecosystem management and nature-based solutions.

Vegetation and habitat classification of anthropogenic communities

Our analysis supports the existence of ~~28~~25 anthropogenic alliances in the vegetation of the Iberian Atlantic ~~ecoregion~~territories. While the core of this vegetation diversity is made up of temperate European alliances, these are enriched by the occurrence of eight Mediterranean alliances (*Galio valantiae-Parietarion judaicae*, *Polycarpion tetraphylli*, *Allion triquetri*, *Chenopodion muralis*, *Echio-Galactition tomentosae*, *Paspalo-Agrostion semiverticillati*, *Silybo mariani-Urticion piluliferae* and *Balloto-Conion maculati*~~ and *Cynancho-Convolvulion sepium*~~); plus three alliances that are endemic of the Iberian coasts (*Linario polygalifoliae-Vulpion alopecuri*) and mountains (*Carduo carpetani-Cirsion odontolepidis*, *Cirsion richterano-chodati*) (Mucina et al. 2016). ~~Seven~~Five of these alliances had been reported as absent or uncertain in the ~~ecoregion (*Caucalidion lappulae*, ~~Iberian Atlantic territories (*Chenopodion muralis*~~),~~) or only present in the Portuguese sector of the ~~ecoregion~~area (*Spergulo arvensis-Erodion cicutariae*, *Allion triquetri*, *Echio-Galactition tomentosae*, *Carduo carpetani-Cirsion odontolepidis*~~, *Cynancho-Convolvulion sepium*~~) by the recently published distribution maps of vegetation alliances in Europe (Preislerová et al. 2022).~~ Our dataset supports that six of these alliances are relatively well distributed in the ecoregion, while *Caucalidion lappulae* only has isolated occurrences.~~

On the other hand, our dataset does not support the occurrence in the ~~ecoregion~~Iberian Atlantic territories of nine ~~Mediterranean ~~alliances (*Caucalidion lappulae*, *Roemerion hybridae*, ~~*Diplotaxion erucoidis*, ~~*Euphorbion prostratae*, ~~*Alysso granatensis-Brassicion barrelieri*, ~~*Hordeion murini*, *Taeniathero-Aegilopion geniculatae*, ~~*Parietarion lusitanico-mauritanicae*, ~~*Onopordion castellani*, ~~*Silybo mariani-Urticion piluliferae*) and one temperate alliance (~~*Onopordion acanthii*, *Fragarion vescae* and *Aegopodion podagrariae*) that had been cited as potentially occurring here (Izco et al. 2000; Mucina et al. 2016; Díaz González 2020; Durán Gómez 2020; Preislerová et al. 2022). ~~For habitat classification purposes, we propose that this vegetation diversity can be summarized into 15 EUNIS habitat types: one constructed habitat (*J2.5*), ten vegetated human-made habitats (*V11*, *V12*, *V13*, *V15*, *V32*, *V35*, *V34*, *V37*, *V38*, *V39*), three habitats of woodland fringes and clearings and~~

~~tall forb stands (*R54*, *R55*, *R57*) and one habitat of periodically-exposed shores (*Q61*). In general, we have followed the correspondence between alliances and EUNIS habitats proposed by the EUNIS expert system (), except for *Echio-Galactition tomentosae* which, in the context of the ecoregion, seems to be more adequately placed in the habitat *V37 Annual anthropogenic herbaceous vegetation* rather than in the habitat *V33 Dry Mediterranean land with unpalatable non-vernal herbaceous vegetation*~~Of course, the fact that these nine alliances are not supported by our numerical methods only indicates that they are poorly represented in our dataset and should not be taken as absolute proof that they are absent from the Iberian Atlantic territories.

Since our goal was to match the ~~classification of the ecoregion~~ classification to the EuroVegChecklist (Mucina et al. 2016), we refrained from merging recognized alliances or changing their assignation to superior syntaxa. However, there are some cases that could deserve further scrutiny. For example, the two wall alliances (*Galio valantiae-Parietarion judaicae* and *Cymbalario-Asplenion*) had a large overlap in their geographic distribution, their floristic composition, their proportion of alien species, their community traits~~,~~ and their ecological preferences. These two alliances are well recognized in the European literature~~,~~ and they are generally interpreted as representing the Mediterranean (*Galio valantiae-Parietarion judaicae*) and temperate (*Cymbalario-Asplenion*) versions of wall vegetation (Brullo & Guarino 1998; Jasprica et al. 2021). It is therefore not surprising that in biogeographic transitional regions - such as the Iberian Atlantic territories - these two alliances coexist and show a high overlap. ~~Also, there was overlap between the alliances *Geo urbani-Alliarion officinalis* and *Aegopodion podagrariae*, two alliances that can occupy~~

~~ruderal to semi-natural nitrophilous fringes, and which are mostly differentiated by dominant vegetation height, as was supported by our dataset.~~

For habitat classification purposes, we propose that this vegetation diversity can be summarized into 25 EUNIS habitat types: two constructed habitats (*J2.5*), three habitats of arable crops and gardens (*V1*), 16 habitats of anthropogenic grasslands (*V3*), two habitats of woodland clearings and fringes (*R5*) and two habitats of periodically-exposed shores (*Q61*). In general, we have followed the correspondence between alliances and EUNIS habitats proposed by the EUNIS expert system (Chytrý et al. 2020), except for *Echio-Galactition tomentosae* which, in the context of the study area, seems to be more adequately placed in the habitat *V37 Annual anthropogenic herbaceous vegetation* rather than in the habitat *V33 Dry Mediterranean land with unpalatable non-vernal herbaceous vegetation.*

Characterization of anthropogenic communities

We found 22% non-native species (including neophytes and archaeophytes) in the anthropogenic vegetation of the Iberian Atlantic ~~ecoregion~~territories. This percentage is intermediate between that found in urban areas of temperate Europe and North America (30-50%) (Pyšek 1998; Clemants & Moore 2003; La Sorte et al. 2007; Lososová et al. 2012) and Italy (12-26%) (Celesti-Grapow & Blasi 1998). A survey of anthropogenic vegetation in the north-west Balkans found 13% non-native plants, with more neophytes than archaeophytes (Silc et al. 2012). A similar study in the Czech Republic found 32% archaeophytes and 7% neophytes (Simonova & Lososová 2008). Taken together, these results suggest that the Iberian Atlantic anthropogenic vegetation shows an incidence of non-native species that is intermediate between southern and central-northern Europe, which is in agreement with the biogeographical position of our ~~ecoregion~~study area. Previous studies also suggested that the non-natives were more frequent in early successional anthropogenic communities (Pyšek et al. 2004~~),~~) and our results confirmed this as the proportion of native species tended to be higher in the perennial ruderal classes *Artemisietea vulgaris* and *Epilobietea angustifolii*. The classes with more non-native species also tended to be those adapted to more frequent and more severe disturbances (*Papaveretea rhoeadis*, *Digitario sanguinalis-Eragrostietea minoris*, *Sisymbrietea*), also in agreement with previous research (Simonova & Lososová 2008). Archaeophytes had a higher proportion in the vegetation associated to arable habitats (*Papaveretea rhoeadis*, *Digitario sanguinalis-Eragrostietea minoris*, *Sisymbrietea*), in agreement with the ancient origin of archaeophytes during the development of agriculture (Zohary 1950; Preston et al. 2004). On the other hand, neophytes tended to be in higher proportions in vegetation types associated to wet conditions (*Bidentetea*), as has been found in other European regions (Chytrý et al. 2008).

The traits of the Iberian Atlantic anthropogenic communities agreed with those found in other European regions (Lososová et al. 2006; Silc 2010), with more annual species in habitats associated to arable land and more perennials in ruderal habitats~~,~~ and a general dominance of therophytes and hemicryptophytes in the species pool (Tabasevic, Lakusic, et al. 2021). We found that the main drivers of variation in anthropogenic community composition was a gradient from open-dry to shady-wet sites, supporting the importance of the moisture gradient in shaping anthropogenic vegetation (Golovanov et al. 2023). Mesic and moist human-made habitats of the Iberian Atlantic territories harbor perennial communities, some of which are especially rich in native species and have semi-natural characters. At the same time, the wetter habitats have some of the higher prevalences of non-native species.

Conclusions

~~Ecoregion-level synthesis detected a discrepancy between the number of anthropogenic vegetation units described in the literature and the number supported by numerical classification. The diversity of anthropogenic vegetation can be organized into trampled, weed and ruderal communities varying primarily along an axis of abiotic stress. Importantly, the~~The anthropogenic vegetation of the Iberian Atlantic ~~ecoregion~~territories is home to ~~1,162~~more than a thousand plant taxa. This is approximately one third of the whole ~~ecoregion~~regional species pool represented in the SIVIM database (Font et al. 2012~~),~~) and one fifth of the Iberian flora (Ramos-Gutiérrez et al. 2021). More than half of this synanthropic diversity (~~615~~c. 600 taxa) occurs in mesic to wet perennial ruderal vegetation, highlighting the potential of some anthropogenic habitats as a source of biodiversity in human-dominated landscapes (Anderson & Minor 2017; Kowarik 2018). These results suggest three main objectives for the sustainable management of human-made habitats: (1) focusing efforts on alien plant management in anthropogenic plant communities of wet habitats; (2) conserving examples of archaeophyte-rich annual weed communities, especially those linked to traditional agricultural practices (Meyer et al. 2013); and (3) conserving and promoting mesic ruderal and fringe vegetation as a biodiversity refuge in urban and peri-urban areas. We hope that our synthesis of the anthropogenic communities of the Iberian

Atlantic territories serves as a contribution towards a pan-European synthesis of human-made vegetation, a synthesis that could shed light on the coexistence between humans and plants.

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Supplementary Information

Appendix S1 Checklist of anthropogenic syntaxa that could be present in the Iberian Atlantic ~~ecoregion~~territories according to the literature. Syntaxa names are provided as recorded by the original authors of the vegetation plot. The file indicates if the presence of the syntaxon in the Iberian Atlantic ~~ecoregion~~territories was validated or not by our analysis.

Appendix S2 Original publications providing the vegetation plots stored in SIVIM and used in our analysis. Reference details are provided as they are in the SIVIM database.

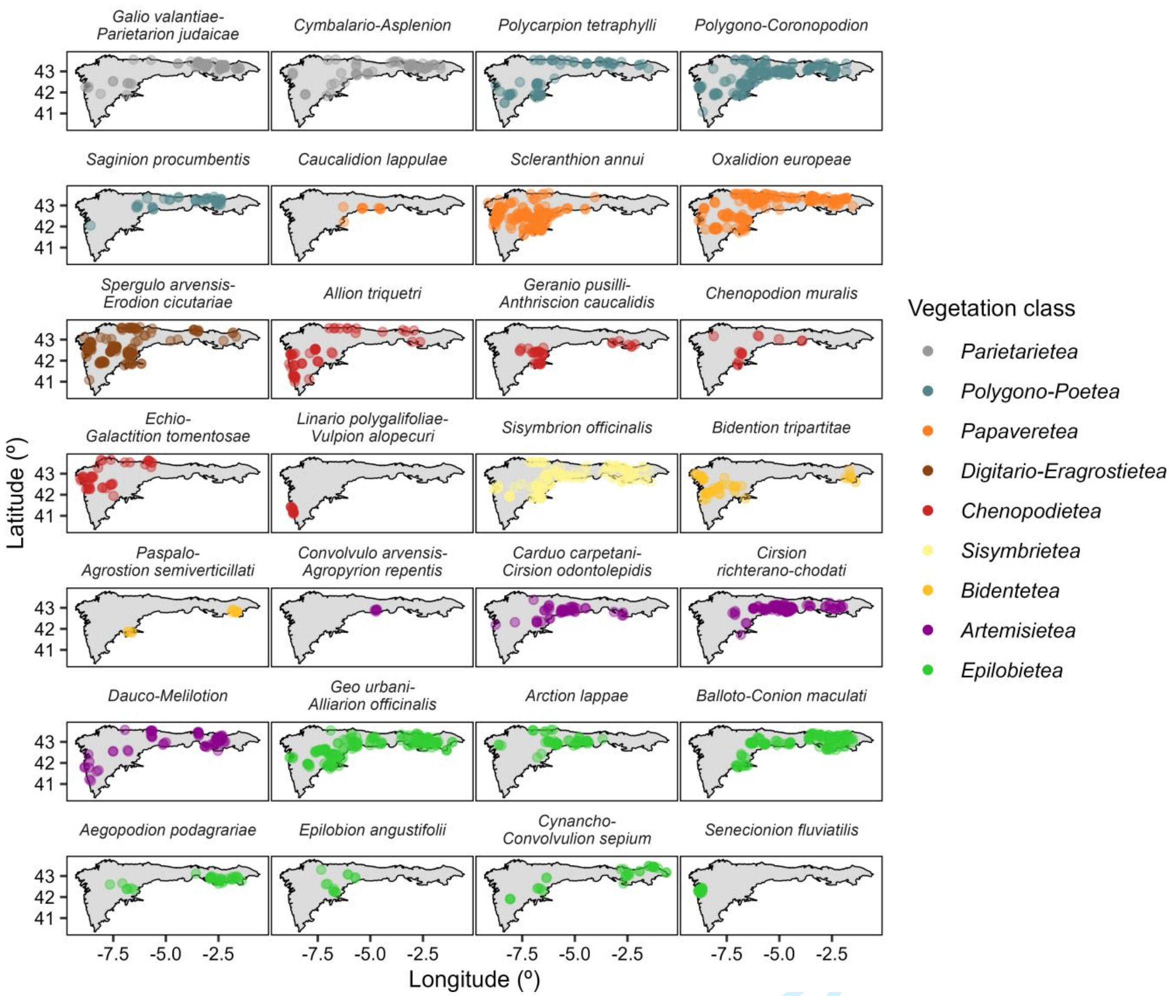
~~**Appendix S3**~~**Appendix S3** Description of the 25 alliances present in the anthropogenic vegetation of the northwestern Iberian Peninsula, and correspondence with regionalized level 4 EUNIS habitats.

Appendix S4 Characteristic species combinations of the anthropogenic vegetation alliances in spreadsheet format, divided into diagnostic, constant~~, and dominant species.~~ and dominant species. The values are as follows: Diagnostic species = *IndVal* multiplied by 100; Constant species = percentage occurrence frequency (constancy); Dominant species = percentage frequency of plots in which the species occurs with a cover larger than 25%.

Appendix ~~**S4** Synthetic description~~**S5** Synoptic table of the ~~28 alliances present in~~fidelity (phi) of the ~~Iberian Atlantic~~diagnostic species of the 25 anthropogenic ~~vegetation~~alliances.

Appendix ~~**S5**~~**S6** Revised checklist of vegetation associations described in the regional literature and belonging to the ~~28~~25 alliances present in the Iberian Atlantic anthropogenic vegetation.

Figures


Galio valantiae-Parietarion judaicae
Cymbalario-Asplenion
Polycarpion tetraphylli
Polygono-Coronopodion
Saginion procumbentis
Caucalidion lappulae
Scleranthion annui
Oxalidion europeae
Spergulo arvensis-Erodion cicutariae
Allion triquetri
Geranio pusilli-Anthriscion caucalidis
Chenopodion muralis
Echio-Galactition tomentosae
Linario polygalifoliae-Vulpion alopecuri
Sisymbrion officinalis
Bidention tripartitae
Paspalo-Agrostion semiverticillati
Convolvulo arvensis-Agropyrion repentis
Carduo carpetani-Cirsion odontolepidis
Cirsion richterano-chodati
Dauco-Melilotion
Geo urbani-Alliarion officinalis
Arction lappae
Balloto-Conion maculati
Aegopodion podagrariae
Epilobion angustifolii
Cynancho-Convolvulion sepium
Senecionion fluviatilis
Latitude (°)
43
42
41
-7.5
-5.0
-2.5
Longitude (°)
Vegetation class
Parietarietea
Polygono-Poetea
Papaveretea
Digitario-Eragrostietea
Chenopodietea
Sisymbrietea
Bidentetea
Artemisietea
Epilobietea

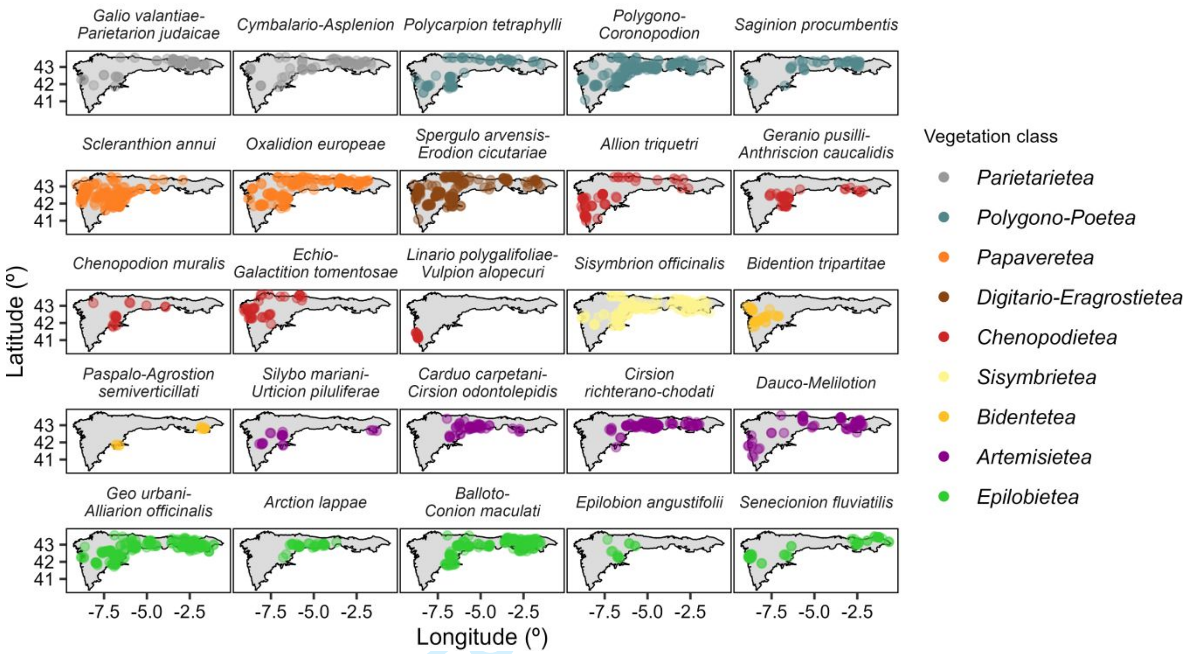
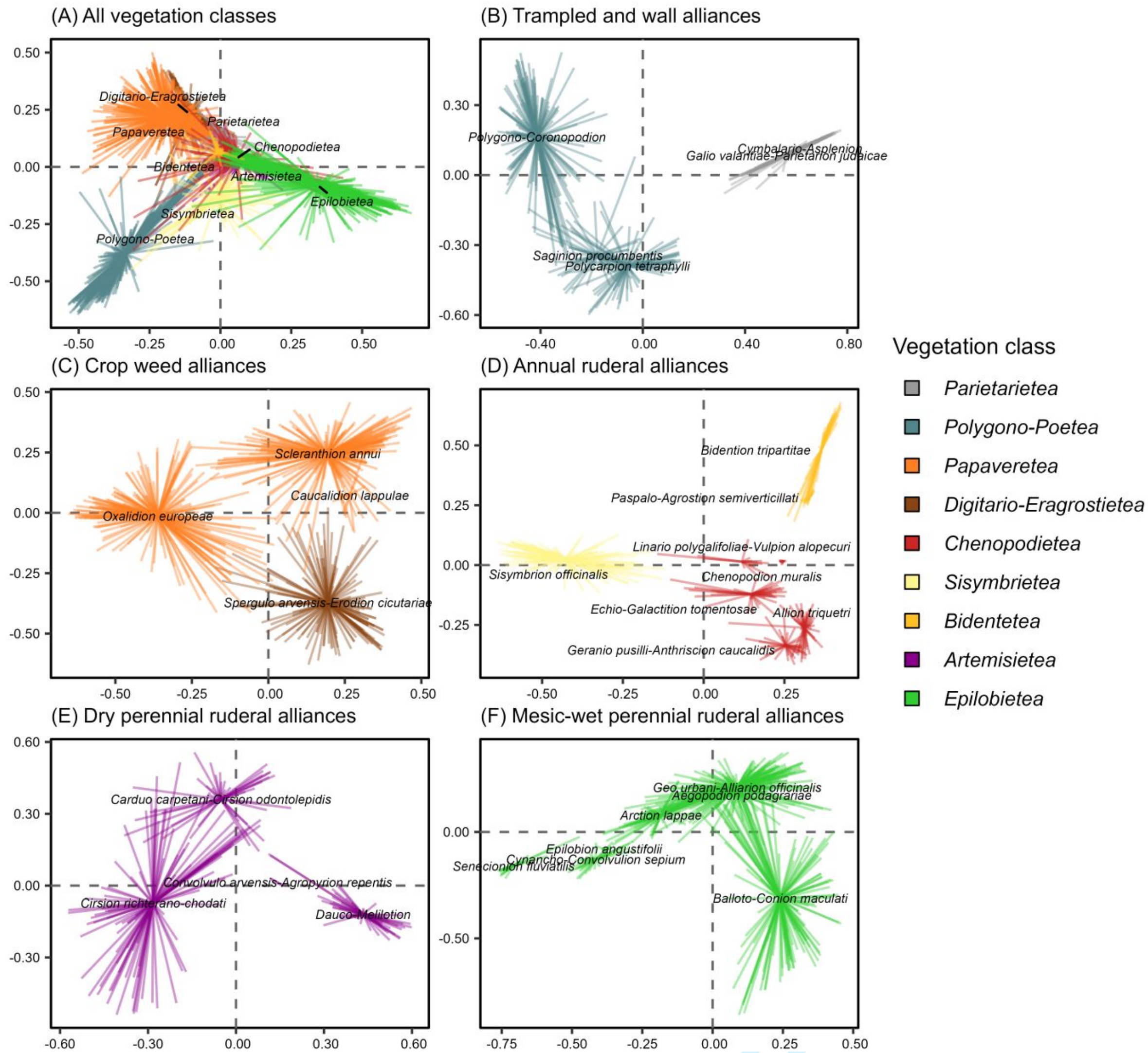


Figure 1: Anthropogenic vegetation alliances of the Iberian Atlantic ~~ecoregion~~territories. Each dot is a vegetation plot. Dot colors indicate the vegetation class.

1 
(A) All vegetation classes
Digitario-Eragrostietea
Parietarietea
Papaveretea
Chenopodietea
Bidentetea
Artemisietea
Epilobietea
Sisymbrietea
Polygono-Poetea
(B) Trampled and wall alliances
Polygono-Coronopodion
Cymbalario-Asplenion
Galio valantiae-Parietarion judaicae
Saginion procumbentis
Polycarpion tetraphylli
(C) Crop weed alliances
Scleranthion annui
Caucalidion lappulae
Oxalidion europeae
Spergulo arvensis-Erodion cicutariae
(D) Annual ruderal alliances
Bidention tripartitae
Paspalo-Agrostion semiverticillati
Linario polygalifoliae-Vulpion alopecuri
Sisymbrion officinalis
Chenopodion muralis
Echio-Galactition tomentosae
Allion triquetri
Geranio pusilli-Anthriscion caucalidis
(E) Dry perennial ruderal alliances
Carduo carpetani-Cirsion odontolepidis
Convolvulo arvensis-Agropyrion repentis
Cirsion richterano-chodati
Dauco-Melilotion
(F) Mesic-wet perennial ruderal alliances
Geo urbani-Alliarion officinalis
Aegopodion podagrariae
Arction lappae
Epilobion angustifolii
Cynancho-Convolvulion sepium
Senecionion fluviatilis
Balloto-Conion maculati
Vegetation class
Parietarietea
Polygono-Poetea
Papaveretea
Digitario-Eragrostietea
Chenopodietea
Sisymbrietea
Bidentetea
Artemisietea
Epilobietea

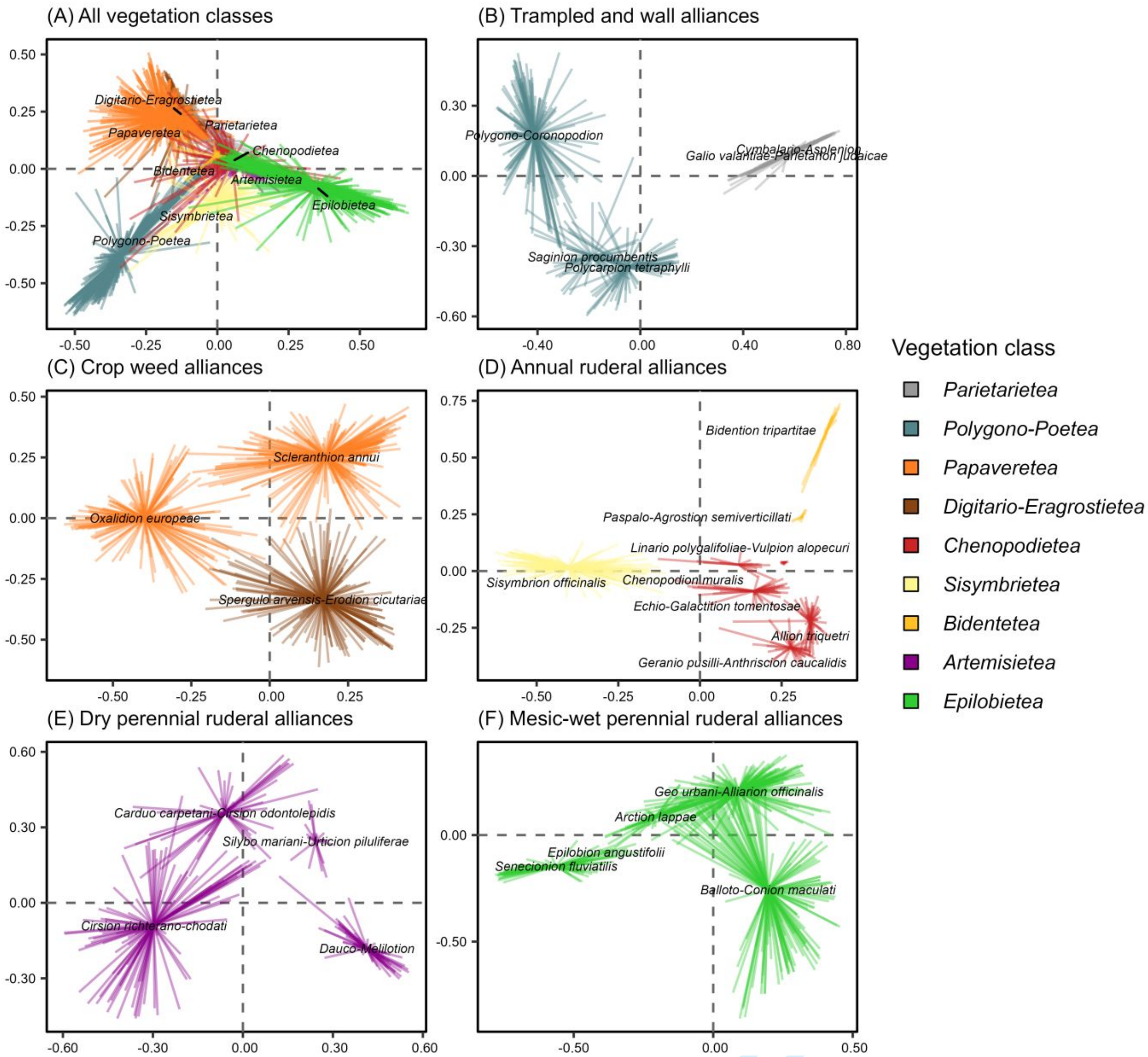


Figure 2: Floristic diversity of the anthropogenic plant communities of the Iberian Atlantic ~~ecoregion~~territories. Biplots produced by Principal Component Analysis (PCA) with Hellinger transformation. PCAs were conducted for the whole vegetation (A) and for specific subsets (B-F). Colors indicate the vegetation class.

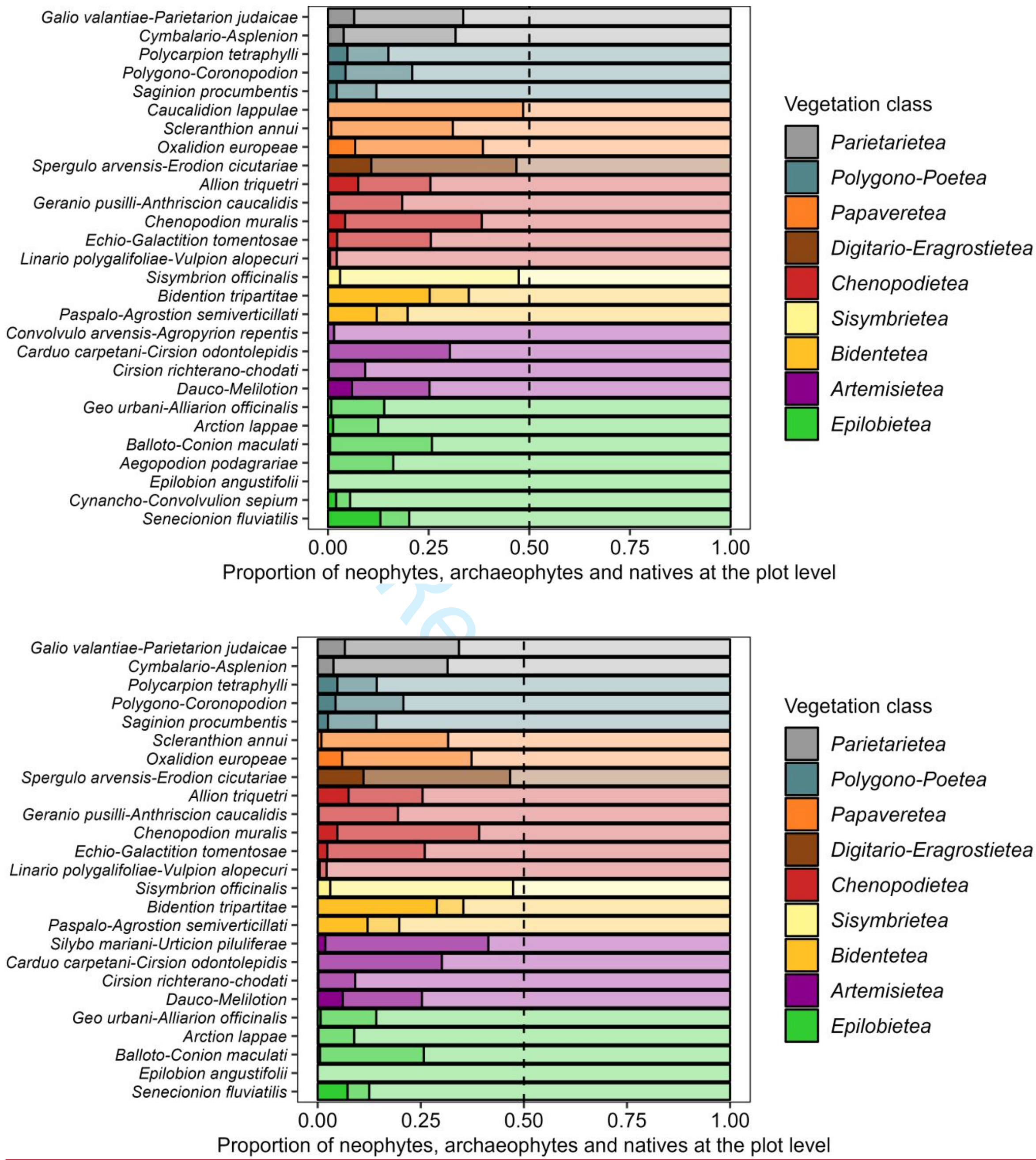
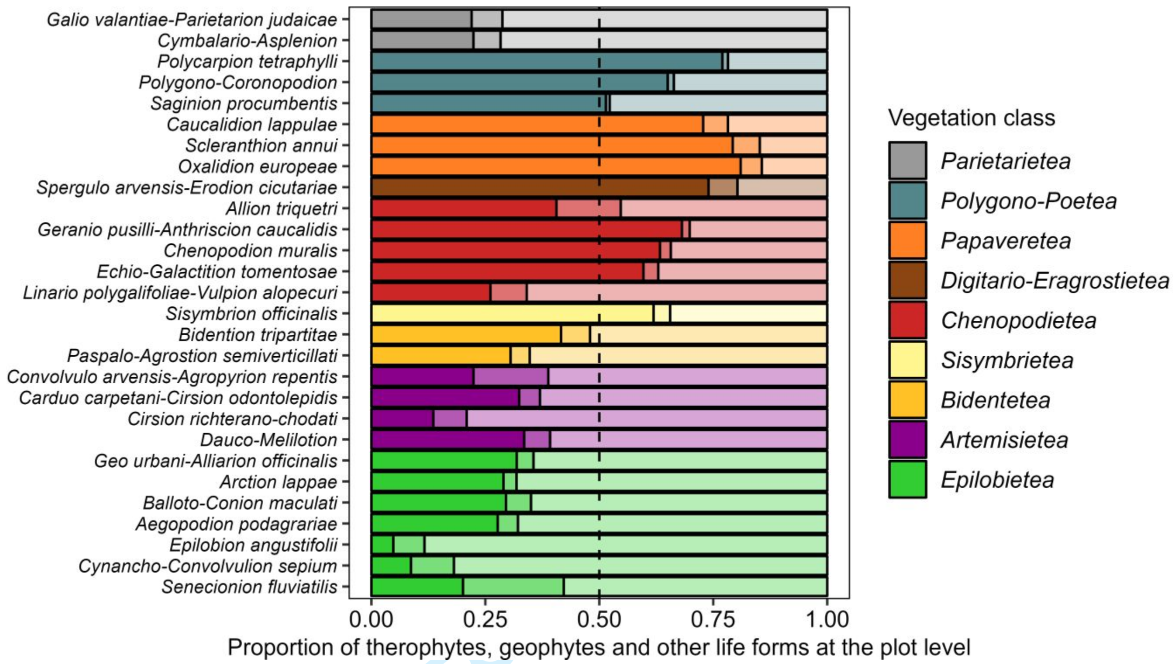


Figure 3: Proportion of neophytes, archaeophytes~~,~~ and native species in the anthropogenic plant communities of the Iberian Atlantic ~~ecoregion~~territories. Each bar represents the plot-level average proportion of neophytes (dark shade), archaeophytes (medium shade~~),~~) and natives (light shade) in each vegetation alliance. Colors indicate the vegetation class.



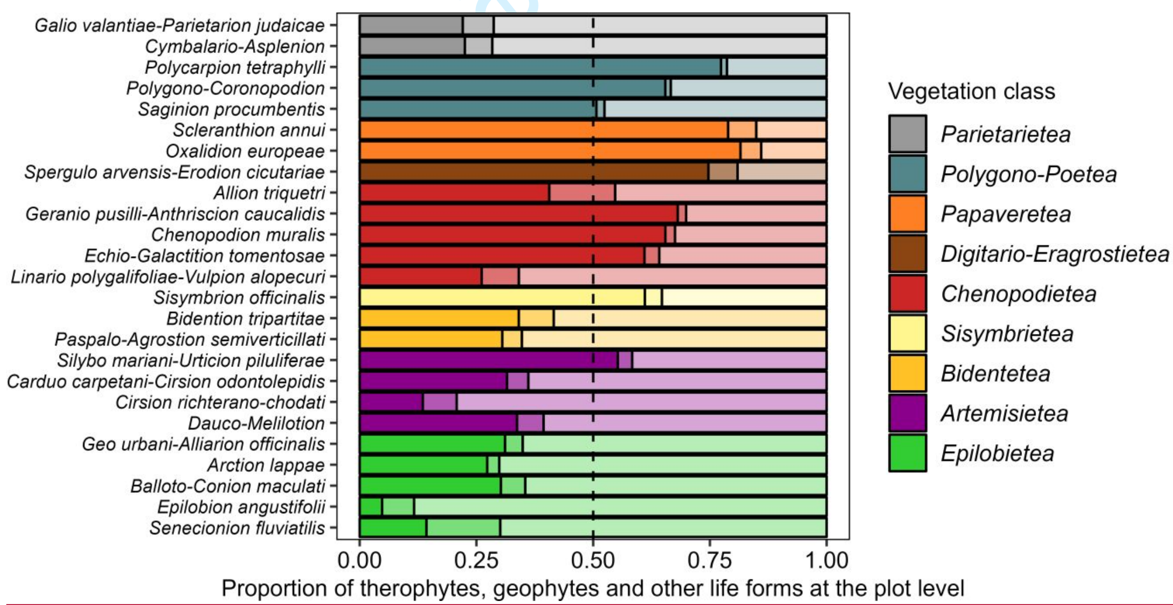
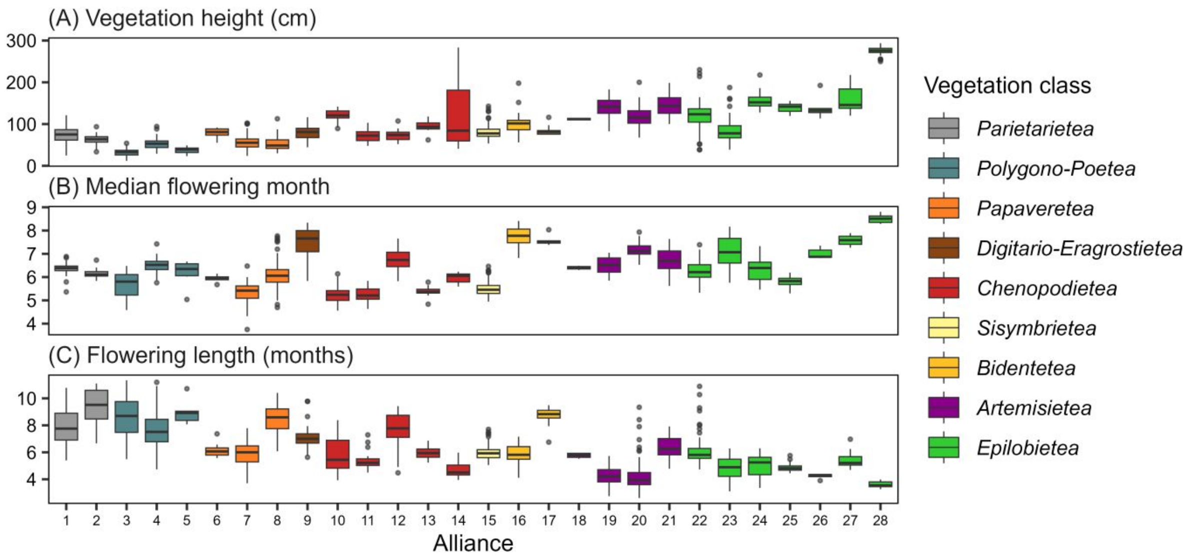


Figure 4: Proportion of therophytes, geophytes~~,~~ and other life forms (hemicryptophytes, chamaephytes, phanerophytes, bryophytes, hydrophytes) in the anthropogenic plant communities of the Iberian Atlantic ~~ecoregion~~territories. Each bar represents the plot-level

average proportion of therophytes (dark shade), geophytes (medium shade~~),~~) and other life forms (light shade) in each vegetation alliance. Colors indicate the vegetation class.



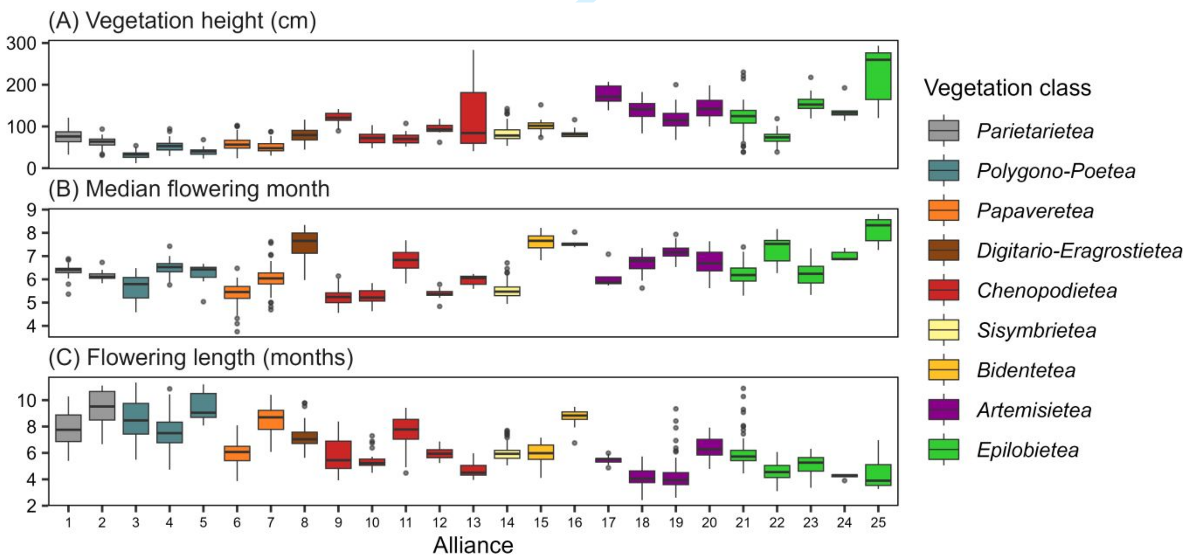
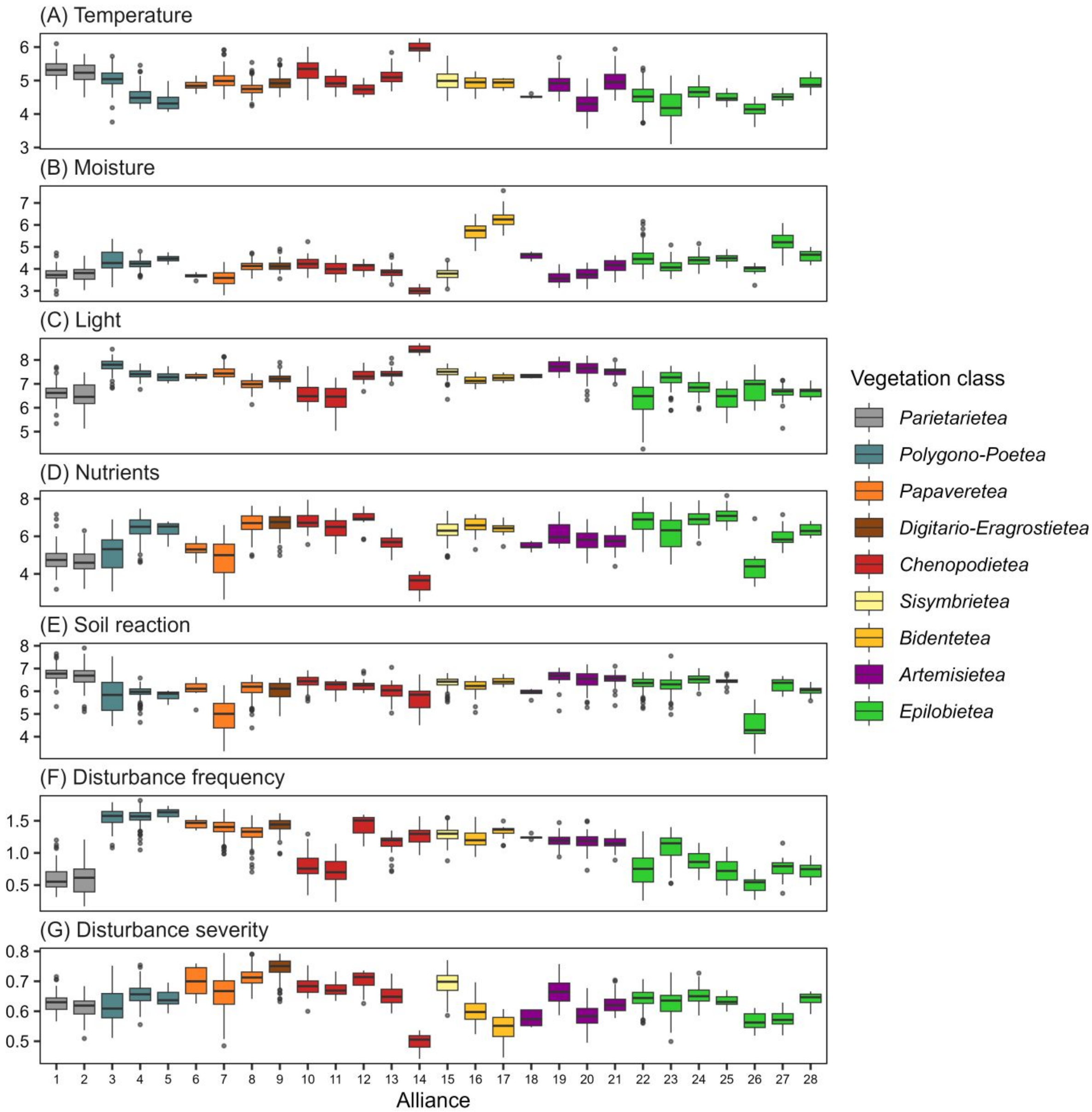


Figure 5: Vegetation height and flowering phenology of the anthropogenic plant communities of the Iberian Atlantic ~~ecoregion~~territories. Boxplots show the community-weighted mean for plant height, median month of flowering~~,~~ and length of the flowering

season for each vegetation alliance. Colors indicate the vegetation class. Alliances as ordered as in Figures 1 and 3-4~~,~~ and alliance numbers are the same as listed in Appendix ~~S4~~S3.


(A) Temperature
(B) Moisture
(C) Light
(D) Nutrients
(E) Soil reaction
(F) Disturbance frequency
(G) Disturbance severity
Alliance
Vegetation class
Parietarietea
Polygono-Poetea
Papaveretea
Digitario-Eragrostietea
Chenopodietea
Sisymbrietea
Bidentetea
Artemisietea
Epilobietea

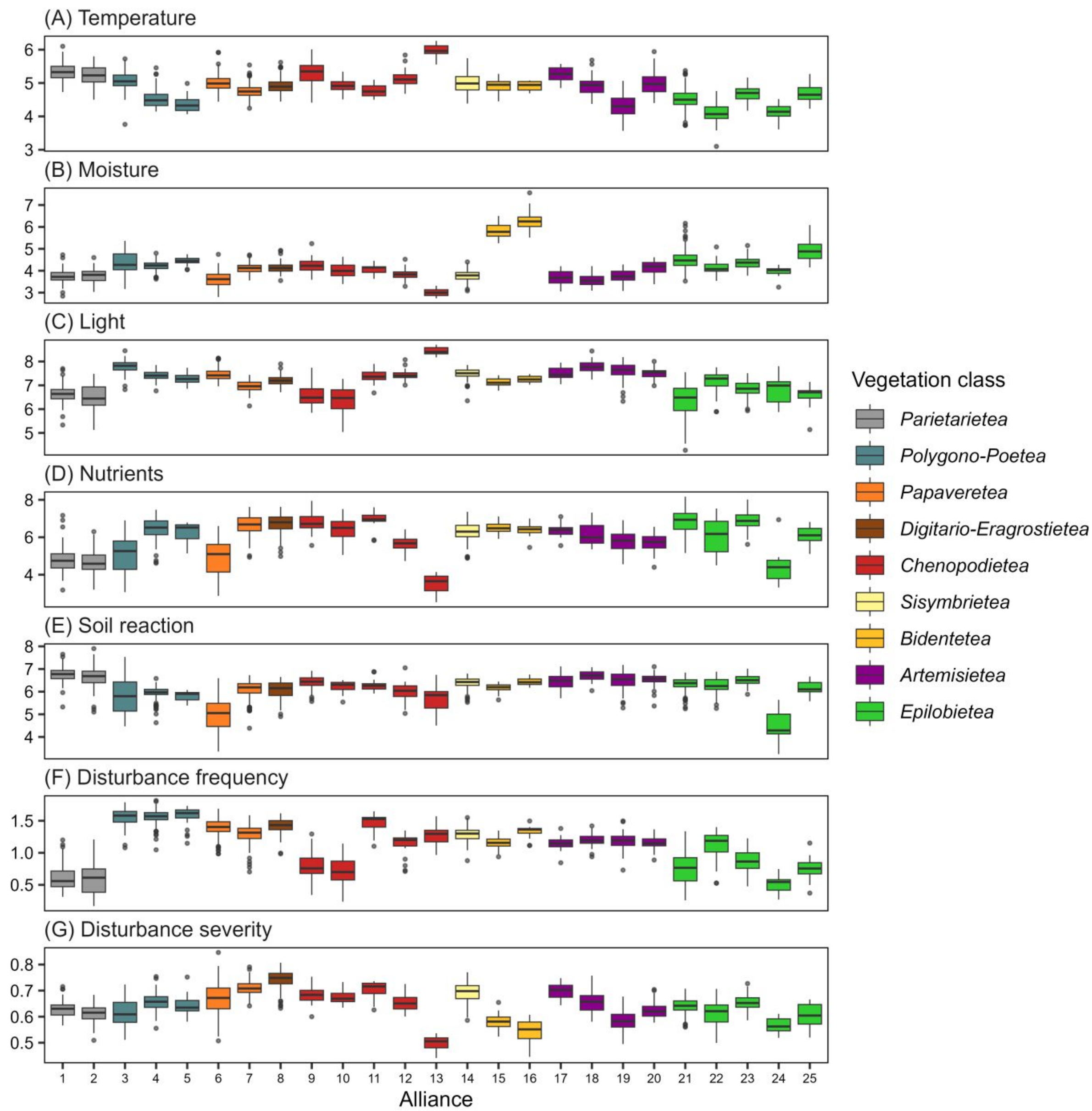
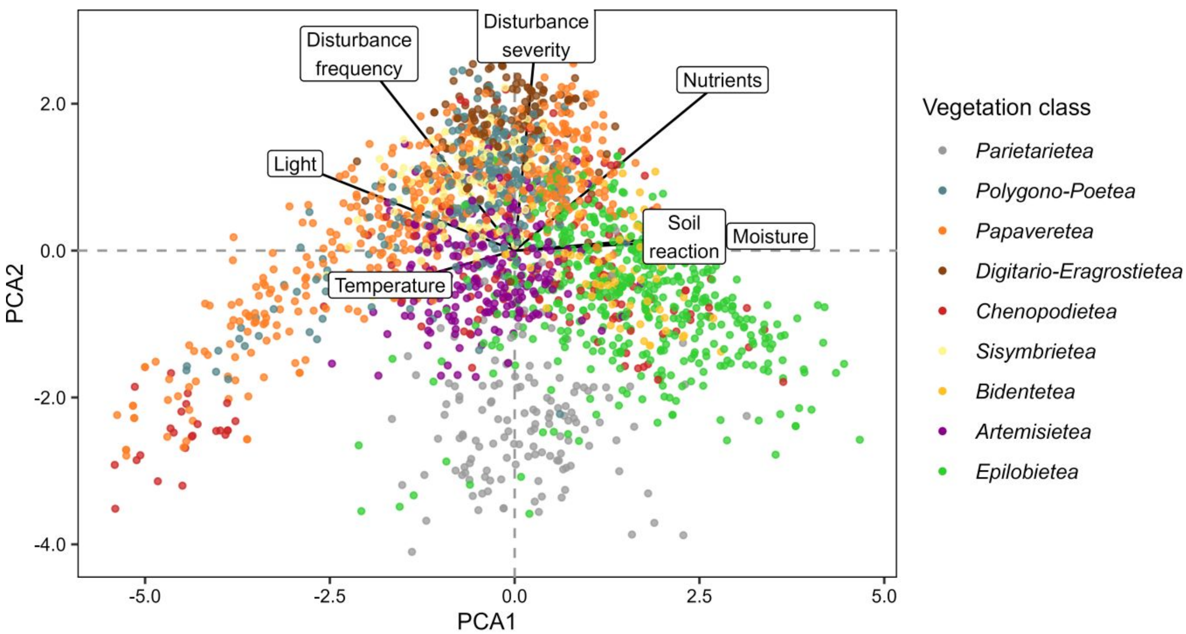


Figure 6: Ecological requirements of the anthropogenic plant communities of the Iberian Atlantic ~~ecoregion~~territories. Boxplots show the plot-level means for the ecological indicator values of temperature, moisture, light, nutrients, soil reaction, disturbance frequency~~,~~ and disturbance severity, calculated for each vegetation alliance. Colors indicate the vegetation

class. Alliances as ordered as in Figures 1 and 3-4~~,~~ and alliance numbers are the same as listed in Appendix ~~S4~~S3.



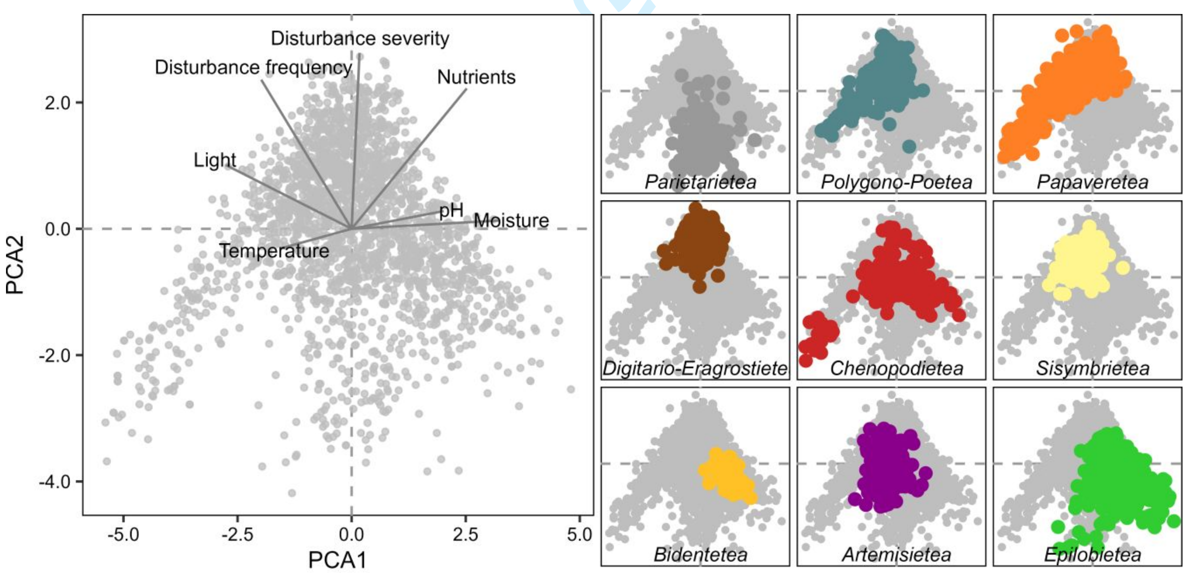


Figure 7: Ecological requirements of the anthropogenic plant communities of the Iberian Atlantic ~~ecoregion~~territories. Biplot produced by Principal Component Analysis (PCA) of

the plot-level means for the ecological indicator values of temperature, moisture, light, nutrients, soil reaction, disturbance frequency~~,~~ and disturbance severity. ~~Labels~~Each dot is a plot. In the left panel, labels and arrows indicate the contribution of each indicator to the first and second principal components. ~~Colors indicate~~The right panels show the space occupied by each vegetation class~~.~~ *(colored dots) with respect to the whole anthropogenic vegetation (grey dots).*

Response letter on the manuscript Classification and characterization of anthropogenic plant communities at the ecoregion level

Co-ordinating Editor Comments to Author

Dear authors, I found this study interesting, even if limited to a relatively short geographical area. I believe this study can also be relevant at the European scale; therefore, I think it is suitable to be published in AVS. However, I agree with the referees that the manuscript can be significantly improved before publication.

We would like to thank the editor and the reviewers for the time invested in reviewing our manuscript and providing constructive comments. We have revised the manuscript to incorporate all the suggestions. Please find below a point-by-point response to each comment.

Referee 1

In general, the survey is interesting and has been conducted correctly in the analysis procedure and the results yielded are consistent and respond to the initial questions. For that reason I consider it can be published in AVS. However, in the comments below are suggested some changes, mostly in the introduction, and other changes are highlighted in the notes over the manuscript. I recommend to accept the paper with major changes.

Thank you for your positive evaluation and your useful comments, which we have integrated into a revised version of the manuscript.

The title does not have any indication of the geographical frame of the survey and it is relevant to indicate it to potential readers. It is in the keywords but it should be in the title.

We agree and we have changed the title to *Classification and characterization of anthropogenic plant communities in the northwestern Iberian Peninsula.*

The entire article is built up using the frame of the concept of ecoregion (Bailey 2004, 1989; Olson et al. 2001). About this there are two related questions: 1 What is the benefit of using such biogeographic frame in terms of how the results or the interpretations could be altered or deteriorated if not used? Is it a merely geographical description of the study area? If so, then, 2 What is the difference of considering the ecoregions instead the classical biogeographic units such as regions, in the sense of Good or Takhtatajan? It is important to quote that biogeographic regions also include vegetation units living within them as was established early in the 20th century by Flauhaut and Braun-Blanquet (Loidi 2021)

We would argue that the manuscript is built up based on the idea that this type of studies should be conducted using biogeographical units, regardless of the rank or classification system of the unit. In our specific example, focusing on the Iberian Atlantic territories (which rank would be "province", but see below for a discussion of the definition of the Iberian Atlantic territories and its correspondence with different biogeographical classifications) allows to study a territory that shares (1) a similar macroclimate and (2) a shared biogeographical history, including a history of biological invasions. This is especially important when studying anthropogenic vegetation, to define lists of regional neophytes and archaeophytes, which would be not possible if considering a larger area (for example, most "archaeophytes" and some "neophytes" would be considered "native" at the European level) or a smaller area or political unit (for example, species native to some parts of the Iberian Atlantic territories are some times considered "alien" in some other parts, e.g. *Pinus pinaster*). This can allow to make comparisons between invasion levels in different vegetation types in different regions, see for example Chytrý et al. (2008).

We have revised the usage of the term "ecoregion" throughout the manuscript, to avoid giving the false impression that we are specially interested in the ecoregion concept and classification by Olson et al. (2001), rather than in studying the Iberian Atlantic territories as a biogeographically-coherent unit.

It seems that the plots used are original of NW Iberia, as shown in Figure 1. The boundaries of the grey area, supposedly taken from the map of Olson et al. 2001, are quite coincident with what has been profusely named as Cantabro-Atlantic subprovince by Rivas-Martínez (Rivas-Martínez et al. 2017) and related authors such as Fernández Prieto et al. 2020, 2023. I would suggest to use these units and names to prevent from nomenclatural inflation and cite the corresponding papers (see below). If we comment the names, the name "Iberian Atlantic" is not so precise as "Cantabro-Atlantic". The former could include southern Portugal (Algarve or Vicentine Coast), which is not at all the case. To use the term Cantabrian or Cantabrico is particularly precise to indicate the geographic position of this territory. Additionally, it would be necessary to make a more formal description of the "Iberian Atlantic ecoregion" and discuss the differences from this ecoregion with the "Cantabro-Atlantic subprovince".

We agree that the definition and name of the studied biogeographical unit requires further clarification. First, we must make it clear how we define our study region: "the territories with a temperate climate in the north-western part of the Iberian Peninsula". In other words, we are following precisely the definition by Fernández Prieto et al. (2020) in *Naturalia Cantabricae* 8(2): 30-37. More specifically, we are following the geographical limits presented in Figure 1 of Fernández Prieto et al. (2020).

The concept of this biogeographical unit as presented by Fernández Prieto et al. (2020) is essentially equivalent to the *Cantabrian Mixed Forests ecoregion* by Olson et al. (2001). The major difference between the two concepts is in the southern borders of the region, which are much more precisely drawn in Fernández Prieto et al. (2020).

However, the biogeographical unit does not correspond with Rivas-Martínez's *Cantabro-Atlantic subprovince*, as there are two deviations from that concept. First, our study region also includes Rivas-Martínez's *Orocantabrian subprovince*. Second, Rivas-Martínez's *Cantabro-Atlantic subprovince* includes a larger portion of French territory than our study region. Moreover, the *Cantabro-Atlantic subprovince* was not a stable entity in the third versions of Rivas-Martínez's map. For example, in the first edition, it extended in France from the French Basque country in the south to Calais in the north. In the second edition, the extent in the north was reduced to the Cotentin Peninsula in Normandy. Regarding the third edition, we have been unable to check it, since it is not available in digital format. In sum, the more precise correspondence between our study region and Rivas-Martínez's biogeographical classification would be "the Iberian part of the *European Atlantic province*". We include this equivalence in our methods section, in the subsection "Biogeographical territory under study".

Finally, we agree that, from a geographical point of view, "Iberian Atlantic" can refer to the Iberian coast down to Gibraltar, but the term "Atlantic" is used here in a bioclimatic sense, in accordance with the definition by Fernández Prieto et al. (2020) and the biogeographical unit names by Rivas-Martínez (cf. *European Atlantic province* in Rivas-Martínez et al. (2014)) and the European Union's Natura 2000 framework (cf. *Atlantic biogeographical region*, https://www.eea.europa.eu/en/analysis/maps-and-charts/biogeographical-regions-in-europe-2).

In any case, to avoid confusion, we have revised the manuscript's section "Biogeographical territory under study" [page 7, lines 8-17] to better explain the study area and its equivalence in different classifications. We have also revised the whole manuscript to avoid using the term *Iberian Atlantic ecoregion*, which mixes the concepts *Cantabrian Mixed Forests ecoregion* by Olson et al. (2001) and *Iberian Atlantic territories* by Fernández Prieto et al. (2020). Now, we use *Iberian Atlantic territories* in accordance with Fernández Prieto et al. (2020). We have also added the reference to Fernández Prieto et al. (2023) which further supports the definition of the studied biogeographical unit.

One of the main results of this survey is the selection of 28 alliances (appendix S4) from an initial set of 38 that could be present in the Iberian Atlantic ecoregion. So, I understand that there are 10 alliances have not been detected. It would be interesting to list them somewhere (in appendix S2, for instance) and make clear that no data from them have been found in the datasets.

We list them in the methods [from page 10, line 21 to page 11, line 4] and the discussion [page 19, lines 14-22]. These alliances were present in the dataset in the sense that the relevés had been assigned to syntaxa belonging to these alliances by the original authors of the relevé. However, the alliances were not supported by our numerical classification, i.e. their relevés were assigned to another alliance, or to the noise group.

Concerning the weakly represented alliances. This is inevitable if we start with a definition of the study area prior to surveying its plant communities. There will be always some types which are found in the extreme or border of its geographical area or ecological amplitude and are, thus, weakly represented. It is an inherent problem of such a territorial planning and has to be conveniently considered. Other possibility is to choose the vegetation alliances and study them in all their geographic amplitude. This would entail that their geographical territory would be diverse but the survey would bring more accurate results about their character and differences.

We agree that the risk exist, although we believe that this risk is lessened by focusing on a biogeographical unit rather than in e.g. a political division. Furthermore, there were alliances that are only found in the extremes (i.e. the contact with the Mediterranean region) of the study area, but still they were supported by the numerical classification. We believe that the fact that the missing alliances were not supported by the numerical classification indicates that the relevés that had been assigned to these alliances are poor representatives of the vegetation types, and more likely transitional communities at the extreme of the alliance distributions.

In S2 author's names should be corrected and homogenized e.g. Lence Paz is C. or Carmen, all the patronimic names such as Pérez, Fernández, etc„ have an accent but have instead a strange signal in the involved letter. It is Rivas-Martínez, not Rivas Martínez; Is it Romero or Romero Buján?, etc.

In Appendix S2, author names are provided exactly as they are stored in the SIVIM database. This is necessary to ensure cross-referencing between our dataset and the SIVIM database. We have specified this in the heading of the Appendix S2.

In the figure 1 the area does not include any French terrotory [. . .] In the maps of figure 1 there is no French territory included

The figure includes a portion of French territory in the Pyrénées-Atlantiques department, following the biogeographical borders shown by Fernández Prieto et al. (2020) in their Figure 1, although our figure may be to small to fully appreciate this. We have revised the mention in the abstract to make clear that we are speaking about SW France.

Anthropogenic syntaxa have a larger biogeographical scope than other vegetation types, particularly grasslands and scrub, but they have narrower distribution than others such as aquatic vegetation. On the other hand, they have been described by traditional phytsociology after fine ecological variations. If there is inflation it should be somhow documented.

We have removed this sentence from the revised version.

There are several papers on this topic published in the area by Loidi and other authors, they are quoted in the adjointed sheet

Thank you for these references, we have incorporated them into our manuscript.

classification at the alliance level ..

We have updated the text as suggested.

In this paper only forest and mantle communities are dealt, no nitrophilous vegetation.

We cite this reference as the basis for defining the borders of our study biogeographical territory, we have revised the text to make this clear.

In these disturbed communities, geophytes, with some exceptions, use to be scarce. Do you think neccesary to highlight their proportion more than other life-forms? It seems to me that the main point is to describe the relative importance of hemicriptophytes in relation to therophytes as they become dominant in their respective alliances.

We agree that, in most of the alliances, only the variation of hemicryptophytes vs. therophytes is relevant. However, the presence of geophytes is an important part of the description of some of the alliances (e.g. see the description of *Allion triquetri* by Mucina et al. (2016): *Mesic nitrophilous geophyte-rich fringe vegetation of the Western Mediterranean*). Furthermore, the variation in geophytes explained a significant part of the overall variance in an exploratory PCA. For these two reasons, we decided to highlight the proportion of geophytes in our manuscript.

This figure is difficult to read. Point clouds overlap and the information is partially not visible. I suggest to use two figures for the same PCA, each one representing a half of the alliances selected in form that overlpings are avoided. This could also allow to use larger dots which would be more easily identified by the color.

Thank you for your suggestions to improve Figure 7. We have provided a new version of the figure, where each vegetation class is represented separately.

It should be cited as: Castroviejo, S. (coord. gen.). 1986-2020. Flora iberica. Real Jardín Botánico, CSIC, Madrid [and other comments regarding the references]

Thank you for checking our references, we have corrected them as needed.

Referee 2

This paper presents a classification and characterisation of the anthropogenic vegetation alliances of the Iberian Atlantic ecoregion in Europe. The study area is not very large, but I think that the paper is a valuable contribution to the knowledge of this vegetation type in Europe, and it can be considered suitable for AVS after some revision.

Thank you for your positive evaluation and suggestions.

The authors claim that (1) there is a need for a numerical classification and synthesis of the full spectrum of anthropogenic vegetation, and (2) an appropriate scale to conduct such study is the ecological region. While I strongly agree with point 1, I'm less convinced about point 2. Why should a revision at the ecoregion level be superior to a continental pan-European synthesis? I think, both is necessary, and the authors should acknowledge this fact.

We fully agree that a pan-European synthesis would be a worthwhile goal, and we never intended to suggest the contrary. In fact, we would be very happy of any research efforts on continental studies of anthropogenic vegetation. We have added a new final sentence to our conclusions: *We hope that our synthesis of the anthropogenic communities of the Iberian Atlantic territories serves as a contribution towards a pan-European synthesis of human-made vegetation, a synthesis that could shed light on the coexistence between humans and plants.* We also added a similar closing statement to the abstract. We have also modified our text to avoid giving the impression that we are suggesting that the ecoregion (or a similarly ranked biogeographical unit) is the *only* appropriate scale at which one can produce a synthesis of anthropogenic vegetation.

The title is a bit too general. Please consider to add a subtitle such as "a case-study from SW Europe", or something similar.

We agree and have changed the title to *Classification and characterization of anthropogenic plant communities in the northwestern Iberian Peninsula.*

The merits of the applied two-step approach (first a Twinspan classification, then a "semi-supervised" noise clustering) remain unclear to me. More details are needed to fully understand what the authors have done. How many Twinspan clusters did you choose, and how did you determine the optimal number of clusters? How did you match the individual Twinspan clusters with EVC alliances? A crosstab showing the Twinspan clusters and the original alliance assignment should be presented. In the noise clustering, no additional clusters were detected, but plots were allowed to be re-assigned, and a considerable part of the data (17%) remained unclassified in a "noise group". Still, the "semi-supervised" classification is a numerical cluster algorithm. In my opinion, a pure unsupervised classification with subsequent interpretation of the result would have been more straightforward. Re-assignment of plots should be done on the basis of well-defined diagnostic species or using formal definitions, not by applying two numerical algorithms one after another. Or did I miss something important?**

We agree that we may have done a poor job of explaining our classification approach. The main aim of our classification was for it to be consistent with regional phytosociological expertise, and to match that expertise with current EuroVegChecklist alliances (Mucina et al. 2016), not to create a new classification. To achieve this, one advantage of using the SIVIM database is that a majority of the plots had been assigned to associations or alliances by the original authors (Font et al. 2012). However, there could be misclassification due to unclear concepts or human error. Therefore, we used TWINSPAN to revise the classification by the original authors, to define the number of clusters that better aligned with our syntaxonomical checklist, and to remove outliers or misclassified plots. The obtained clusters therefore provided an agreement between phytosociological and numerical classification, and contained only those plots that better represented each alliance. These clusters were then used to assign other plots to the most similar cluster. We think semi-supervised classification is an optimal procedure to reach an agreement between existing and revised classifications (following Tichý et al. (2014), the aim is "preserving the good old units and searching for new ones").

We found that this important point was not clearly explained in the text or the abstract, so we revised the text accordingly [from page 9, line 19 to page 11, line 9]. In the same lines, we have also provided more details on the TWINSPAN procedure as requested by the reviewer.

While revising these aspects, we have repeated all the classification analysis. During the new classification, we found and fixed some errors in the syntaxonomical checklist, as well as in the assignation of TWINSPAN clusters. This has resulted in an improved classification into 25 alliances.

The authors conclude that ten alliances previously reported from the study area do not occur there. This seems a bit hasty. Maybe, these alliances were only represented by a few plots, so they were not detected by the numerical methods.

We note that some alliances were supported by the methods, despite being extreme (ecologically or geographically) for the study region and/or being represented by a few plots. Therefore, we believe that the fact that the missing alliances were not supported by the numerical classification supports that the relevés that had been assigned to these alliances are poor representatives of the vegetation types, and more likely transitional communities at the extreme of the alliance distributions. Nonetheless, we have modified the text to be less conclusive about their absence, by adding the following sentence to the discussion: *Of course, the fact that these nine alliances are not supported by our numerical methods only indicates that they are poorly represented in our dataset, and should not be taken as absolute proof that they are absent from the Iberian Atlantic territories.*

Most importantly, a synoptic table of the alliances is missing. I consider a table showing the constancy of all species in the 28 alliance, with the diagnostic species highlighted, an absolute prerequisite for the paper to be acceptable. A shorted table in the main text would be nice, but there should be a least the full table as supplementary information.

We have included the full synoptic table as Appendix S5.

p5, l11: "non-overlapping definitions" ... different, but certainly overlapping definitions!

We agree, and we have changed it to *"not fully equivalent"*.

p9, l15: Why did you use 15% as cut level, and not 5%? The latter would correspond to the border between Braun-Blanquet class 1 and 2, while 15 cuts the Braun-Blanquet class 2 in the middle. Which cut level then corresponds to Braun-Blanquet class 2?**

Our transformation of Braun-Blanquet values follows the standard of assigning intermediate cover values. Thus, the Burble value 2 (representing 5-25% cover) is transformed to 15% and the value 3 (25-50%) is transformed to 37.5%. Although we could use more approximate pseudospecies levels, the results of TWINSPAN will be the same when the transformation values are selected within the original cover ranges.

p10, l5: Please clarify if the same TwinspanR settings were used as before.

Yes, and we have added this information to the manuscript.

p20, l10: "which are mostly differentiated by dominant vegetation height" ... Is this a new result of your study, or has this been mentioned in the literature (if so, please provide a reference)?

Yes, this is a traditional part of the alliance descriptions, but in any case we have removed the sentence from the manuscript.

p21, l12: "neophytes tended to be in higher proportions in vegetation types associated to wet conditions (Bidentetea)" ... I would have expected an even higher portion of neophytes in the Senecionion fluviatilis. Maybe, plots of alluvial forb communities dominated by neophytes are underrepresented in your dataset?

Our *Senecionion fluviatilis* plots are certainly rich in alien species, specially some communities invaded by *Arundo donax*, in which this species has a mean cover of 74%. However, in these communities, *Arundo donax* is accompanied by many native species (mean = 12 native species per plot) and so the plot-level proportion of neophytes seems low (as it is just the proportion, not weighted by species cover). That being said, it might be possible that plots with neophytes are generally underrepresented across the dataset, because of a sampling bias towards "natural" communities. But this underrepresentation is not necessarily higher in *Senecionion fluviatilis* vs. other alliances.

References: In several references the page numbers are missing!

We have revised the references.

Appendix S3: What is the value for dominant species? Constancy? Mean cover value? Something else? Please clarify.

We have added to the Appendix header the information on how we calculated the values for diagnostic, constant and dominant species.

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