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Farmer's Pride

Networking, partnerships and tools to enhance *in situ* conservation of European plant genetic resources

European crop wild relative diversity: towards the development of a complementary conservation strategy

Citation

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Executive summary

The concept for *in situ* conservation of crop wild relatives (CWR) in Europe developed by ECPGR identifies two major components in the conservation strategic planning. One involves the strategies that are designed and implemented at the national level, whereas the other corresponds to the strategy that should be implemented at the regional level, prioritizing the "big picture" instead of the specific particularities that are often pursued at the country level. The regional strategy for European CWR requires the development of a European CWR priority list, which prioritizes CWR at this scale and sets the reference set of CWR for the development of subsequent conservation assessments. In this study, using socio-economic relevance, between species crossability and threat status as prioritizing criteria, a set of 863 taxa related to human and animal food crops have been selected to constitute the European CWR priority list.

Using this list as a reference, an *in situ* database of population occurrences with high quality georeferencing data has been generated for the territory of Europe plus Turkey. The information was obtained from GBIF and Genesys, two global biodiversity databases, and complemented with additional records gathered from various sources. The raw data downloaded from the above-mentioned sources was curated to eliminate poor quality and erroneous records using a pipeline based in a custom made R script. As a result, this database currently contains 3,130,581 occurrence records including 82.5% of the priority taxa (712 out of 863). In parallel, an *ex situ* database with information on seed accessions kept in genebanks concerning the taxa included in the European CWR priority list was also developed, following a similar procedure. The *ex situ* database contains 136,393 accessions for 457 priority taxa.

An Ecogeographic Land Characterization Map (ELC map) was developed for Europe + Turkey to classify the territory in 37 ecogeographical categories, based on climatic, edaphic and geophysical variables. The ecogeographic categories were used as a proxy to estimate the between population genetic diversity of adaptive value that resides in each target CWR, as a result of the divergent selective pressures operating at the different environments. A total of 6470 so-called CWR-Eco units were obtained by combining the European priority CWR taxa with the ELC categories corresponding to the sites where their populations are found. These 6470 CWR-Eco constitute the conservation targets for which there is available data in the *in situ* database.

The assessment of candidate locations for the establishment of genetic reserves for the active *in situ* conservation of natural populations was performed at two levels: a basic assessment at the level of the countries that are part of the Natura 2000 network and a more complete assessment for the whole Europe + Turkey territory. The assessment made for the Natura 2000 network countries was an update of an earlier study performed in the context of the Farmer's Pride project (Rubio Teso et al. 2020b). As a result of this analysis it was found that 409,642 occurrence records, corresponding to 593 European CWR priority taxa, were located within the N2000 network. In other words, 91% of the European priority CWR included in the *in situ* database are covered by the N2000 network. A hotspot analysis identified the sites with the highest richness of priority CWR. The assessment performed at the Europe + Turkey scale was more detailed and used the 6470 CWR-Eco units as conservation targets. A hotspot analysis performed over a grid of 50x50 km cells identified the cells containing the greatest number of CWR-Eco. Several hotspot areas with more than 200 different CWR-Eco were found in most

western countries. The lower values of CWR-Eco richness found in Eastern Europe and Turkey can be explained by the lower representation of population occurrences in these areas in the *in situ* database. This is partially due to the fact that most countries from these areas do not contribute occurrence data to the GBIF database. The complementarity analysis performed using the protected areas registered at the World Database of Protected Areas (WDPA) and those belonging to the N2000 network showed that 825 protected areas provide coverage to 78% of the target conservation units (5046 of 6470 CWR-Eco). The top 50 protected areas selected through this analysis provide coverage to approximately 50% of the target CWR-Eco. A second complementarity analysis using a grid of 10x10 km cells to take into account those CWR-Eco not found in protected areas identified 853 cells that would be needed to include them.

The analyses performed to identify the contents and gaps of *ex situ* collections showed that around 50% of the European CWR priority taxa have at least one seed accession obtained from a natural population from Europe + Turkey conserved in a genebank. Furthermore, 1906 of the 6470 CWR-Eco conservation targets (29%) are currently stored in genebanks. The complementarity analysis performed to design an optimized collecting strategy showed that it is necessary to collect in 734 50x50 km cells to fully cover the germplasm corresponding to the missing 4564 CWR-Eco. Seed collecting in the top 100 50x50 km cells of the ranking would provide around 73% of the targeted germplasm (3350 CWR-Eco).

The lack of information about the occurrence of some priority CWR taxa and the biased information with little occurrence data for some countries indicates that there are probably other sites that contain a relevant number of targeted CWR-Eco and even a number of new priority CWR-Eco that was not included in this analysis. Nevertheless, since there is not much that can presently be done in this respect, the proposals for candidate sites must be done with the best available data at the time of the study. From the results obtained, it would be advisable to focus on the results of the complementarity analyses with protected areas and with sites outside protected areas, because they provide the most efficient way of maximizing the conservation of CWR diversity with a minimum of sites.

The *in situ* networking recommendations derived from this study involve: 1) the use of CWR-Eco units as the best way to target the genetic diversity of European priority CWR, 2) the use of the existing protected areas for the establishment of genetic reserves, 3) the consideration of the protected areas derived from the complementarity analysis as the best candidate sites for further assessments, 4) the prioritization of the protected areas that occupy the first positions in the complementarity analysis, 5) the on-site verification of the presence of the priority CWR taxa in each of the selected candidate PA, and 6) to underline the need for the creation of a European wide plant survey infrastructure that systematically collates plant biodiversity information homogeneously across the territory to enable, among many other applications, better analyses for the conservation of CWR in Europe.

1. Introduction

The conservation and access to plant genetic resources (PGR) and their genetic diversity is vital for the strengthening of food security and the development of resilient crops under the climate change challenge. Crop wild relatives (CWR) as part of PGR provide high valuable genetic diversity for crop breeding and the improvement of modern varieties, transferring beneficial traits such as tolerance to abiotic stresses and resistance to pests and diseases (Prescott-Allen and Prescott Allen 1983; Maxted *et al.* 1997; Martín-Sánchez *et al.* 2003; Dwivedi *et al.* 2007; Hajjar and Hodgkin 2007; Sonnante and Pignone 2008; Hodgkin and Hajjar 2008; Millet *et al.* 2008; Guarino and Lobell 2011; Nigel Maxted *et al.* 2012; Brozynska *et al.* 2016; Dempewolf *et al.* 2017; Seiler *et al.* 2017; Sharma 2017; Souter *et al.* 2017; Stalker 2017). The development of commercial varieties has led to a loss of genetic diversity within crops, as uniformity facilitates cultivation and harvesting (Esquinas-Alcázar 2005), which makes crops more susceptible to the extreme weather events associated with climate change. The use of CWR in breeding and pre-breeding programmes can provide much of the genetic diversity needed and contribute to secure economic and agricultural sustainability (Prescott-Allen and Prescott Allen 1983; Hoyt and Brown 1988; Hodgkin and Hajjar 2008; Tyack and Dempewolf 2015). As a matter fact, there are recent examples proving their value (see Maxted and Kell 2009; Kilian *et al.* 2020 and references therein).

In the last years, there has been a considerable advance in CWR conservation through new knowledge gathered applying the monographic and floristic approaches. The monographic approach focuses on CWR planning and application at the crop gene pool level: jute (Edmonds 1990), *Vicia* (Maxted 1995), barley (von Bothmer *et al.* 1991; Vincent *et al.* 2012), African *Vigna* (Maxted *et al.* 2004), *Phaseolus* (Ramírez-Villegas *et al.* 2010), *Glycine* (González-Orozco *et al.* 2012), temperate forage and pulse legume species (N. Maxted *et al.* 2012), potato (Castañeda-Álvarez *et al.* 2015), pigeonpea (Khoury *et al.* 2015), and temperate cereals (Phillips *et al.* 2019). While the floristic approach focuses on CWR planning and application at the geographic scale, at the national level (e.g. Maxted *et al.* 2007; Smekalova 2008; Labokas *et al.* 2010, 2018; Fielder *et al.* 2012; Phillips *et al.* 2014; Landucci *et al.* 2014; Panella *et al.* 2014; Jarvis *et al.* 2015; Kell *et al.* 2015; Iriondo *et al.* 2016; Taylor *et al.* 2017; Rubio Teso *et al.* 2018; Mwila *et al.* 2019), and at the regional and global levels (Kell *et al.* 2005, 2017; Magos Brehm *et al.* 2013, 2021; Castañeda-Álvarez *et al.* 2016; Allen *et al.* 2019; Vincent *et al.* 2019; Zair *et al.* 2021). Additionally, new practical initiatives have started aiming at CWR conservation following a complementary approach by the combination of *in situ* and *ex situ* techniques, such as the genetic reserves of celery wild relatives in Germany (Bönisch *et al.* 2015; Frese *et al.* 2018; Bönisch and Frese 2020) and the genetic reserves of CWR in the Biosphere Reserve of Sierra del Rincón in Spain (OAPN 2020). A rich account of these and other practical initiatives targeting the *in situ* conservation of CWR worldwide can be found in Álvarez-Muñiz *et al.* (2021). However, and despite the growing awareness for CWR conservation, their contribution to food security is still not fully recognized (FAO 2010) and their conservation is still neglected both *in situ* and *ex situ* (Maxted 2003; Maxted and Kell 2009; Maxted *et al.* 2016).

At the European level, there have been several EC-funded projects that defined several tools and methodologies to facilitate conservation planning for CWR diversity, such as, PGR Forum (cordis.europa.eu/project/id/EVK2-CT-2002-20010); AEGRO (aegro.julius-kuehn.de/aegro); PGR

Secure (pgrsecure.org) and Farmer's Pride (farmerspride.eu). In parallel, the ECPGR concept for the *in situ* conservation of CWR (Maxted *et al.* 2015) has been developed as a reference framework to be followed, and, as a core activity of ECPGR, the European genebanks taking part in the EURISCO network (Weise *et al.* 2017) are taking steps to improve the representation of CWR in the *ex situ* collections of PGR in Europe. Furthermore, the Global Crop Diversity Trust launched an initiative to locate and collect for *ex situ* conservation under-collected CWR global priority taxa (Dempewolf *et al.* 2014) and this included significant collections from Europe. However, and despite these efforts, there are no existing mechanisms and long-term initiatives coordinating CWR complementary conservation, that would provide the endurable framework for the sustainable use of PGR for food and agriculture and that, ultimately, would provide a transboundary benefit for all European countries. Therefore, setting the basis for a systematic, efficient and common regional approach for CWR genetic diversity conservation is imperative (Maxted 2003; Maxted *et al.* 2013, 2015).

With the aim of setting the basis for an efficient conservation of the genetic diversity of priority CWR in Europe – both *in situ* and *ex situ* – the specific objectives of the current study were to:

1. Identify a list of priority CWR for Europe that will set the main CWR of concern at the regional level;
2. Generate a database of the selected priority CWR for Europe that contains occurrence data about their wild populations in Europe and Asiatic (Anatolian) Turkey, and accessions held in genebanks;
3. Estimate the genetic diversity of adaptive value present in each priority CWR in Europe using ecogeographic information as a proxy, and identify a set of target conservation units for each priority CWR based on this concept;
4. Identify the main hotspots of target conservation units, both within and outside protected areas, based on the available data;
5. Identify, through complementarity analysis, a list of priority protected areas and additional sites where *in situ* genetic reserves of CWR could potentially be established, to actively conserve all previously identified target conservation units;
6. Identify gaps in the *ex situ* collections of CWR;
7. Identify locations for an optimized collection of CWR germplasm and subsequent storage in genebanks, based on the identified gaps.

In this report we describe the methodology used to reach these objectives, we present the obtained results and discuss them providing some recommendations for the design of the European *in situ* network of PGR.

2. Methods

2.1 European priority CWR

To carry out a conservation analysis at the European level it is necessary to generate a priority list of CWR taxa that are of utmost importance at the regional level. Following various criteria associated with the socio-economic relevance of the crops, the crossability of the CWR to their corresponding crops and the threat status of the CWR taxa, an inventory of priority European CWR was developed, building on previous work by Kell *et al.* (2005, 2012, 2014, 2016) and Bilz *et al.* (2011), and using the methodology of Kell *et al.* (2017). The geographic scope of the inventory is Europe, as defined by Hollis and Brummit (2001) and EU territories outside of Europe (i.e., Azores, Canary Islands, Cyprus, East Aegean Islands and Madeira), and Asiatic Turkey. The inventory includes taxa related to human and animal food crops, and native and introduced taxa—although introduced taxa reported to be invasive in any of the European countries were excluded.

2.2 Methodological pipelines

The pipelines followed to identify candidate sites to potentially establish genetic reserves for the *in situ* conservation of CWR and to collect CWR germplasm to fill *ex situ* diversity gaps in genebanks are depicted in Figures 1 and 2, respectively. The geographic scope of the data acquisition process was Europe plus Asiatic Turkey as indicated for the CWR inventory. Each step of this methodology will be explained in detail in the sections below.

2.3 Databases of CWR locations and *ex situ* accessions

The plant distribution database containing *in situ* population occurrences of CWR in Europe + Asiatic Turkey was based on occurrences gathered from two large international biodiversity databases: the Global Biodiversity Information Facility (GBIF – gbif.org/) and Genesys (genesys-pgr.org/) and contained around three million records for 616 priority taxa in 43 countries. This database was obtained after the data underwent a systematic process to filter out all records of poor georeferencing quality, unreliable or likely to contain errors. The specific details about the procedures to download the data and the filtering process are described in detail in Rubio Teso *et al.* (2020a). To fill existing gaps already discussed in that report, Farmer's Pride partners, Farmer's Pride Ambassadors and National Contacts in the European Cooperative Programme for Plant Genetic Resources (ECPGR) were contacted to search for additional occurrence records concerning CWR taxa and/or countries that were not represented or had few records. Data were increased with occurrences from Germany (Thormann, *pers. comm*.), Romania (Sandru, *pers. comm.*), Turkey (Tas *et al.* 2019) and data for CWR taxa of specific genera – *Aegilops*, *Avena*, *Lathyrus*, *Lens*, *Lupinus*, *Medicago*, *Pisum*, *Prunus*, *Secale*, *Triticum* and *Vicia* – (Maxted and Students 2021). Several individual taxon searches were also conducted by herbarium curators from different public herbaria. Additionally, in September 2020, the GBIF database was searched for recent, additional data that might have been included in the last months. The citations corresponding to this second search are available in Annex A. The data was filtered using a script developed in the R environment (R Core Team 2020), following the same process and steps as those taken in the first case (Rubio Teso *et al.* 2020a). Main filters applied included the exclusion of records associated to cultivated material, elimination of inaccurate occurrences (i.e. those with geographic coordinates that did not have at least the accuracy of one decimal degree), elimination of records most likely to be erroneous (such as those occurring in country or capital centroids or those whose coordinates did not match with the reported country), occurrences with geographical coordinates that fall in the sea or with incompatible habitat or land uses (*e.g.,* permanent snow or ice or water bodies), elimination of records dated before 1950, elimination of duplicate records and removal of records of the same taxon occurring in less than one km buffer radius. Further information on the filters and R packages used is available in Rubio Teso *et al.* (2020a, b).

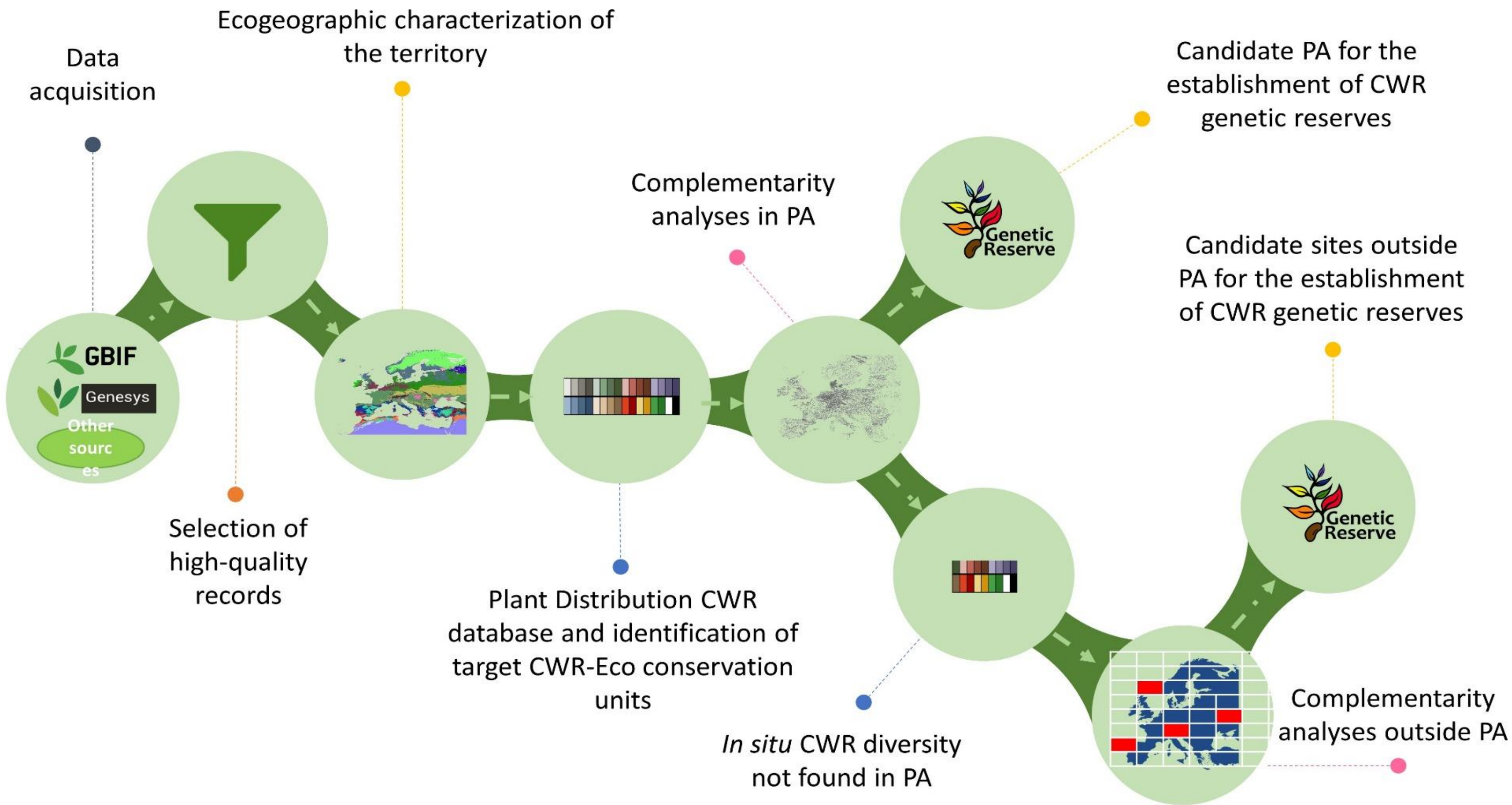

Figure 1: Process followed to obtain a list of candidate *in situ* sites (both within and outside protected areas) where genetic reserves of CWR could be established for *in situ* conservation in Europe + Turkey.

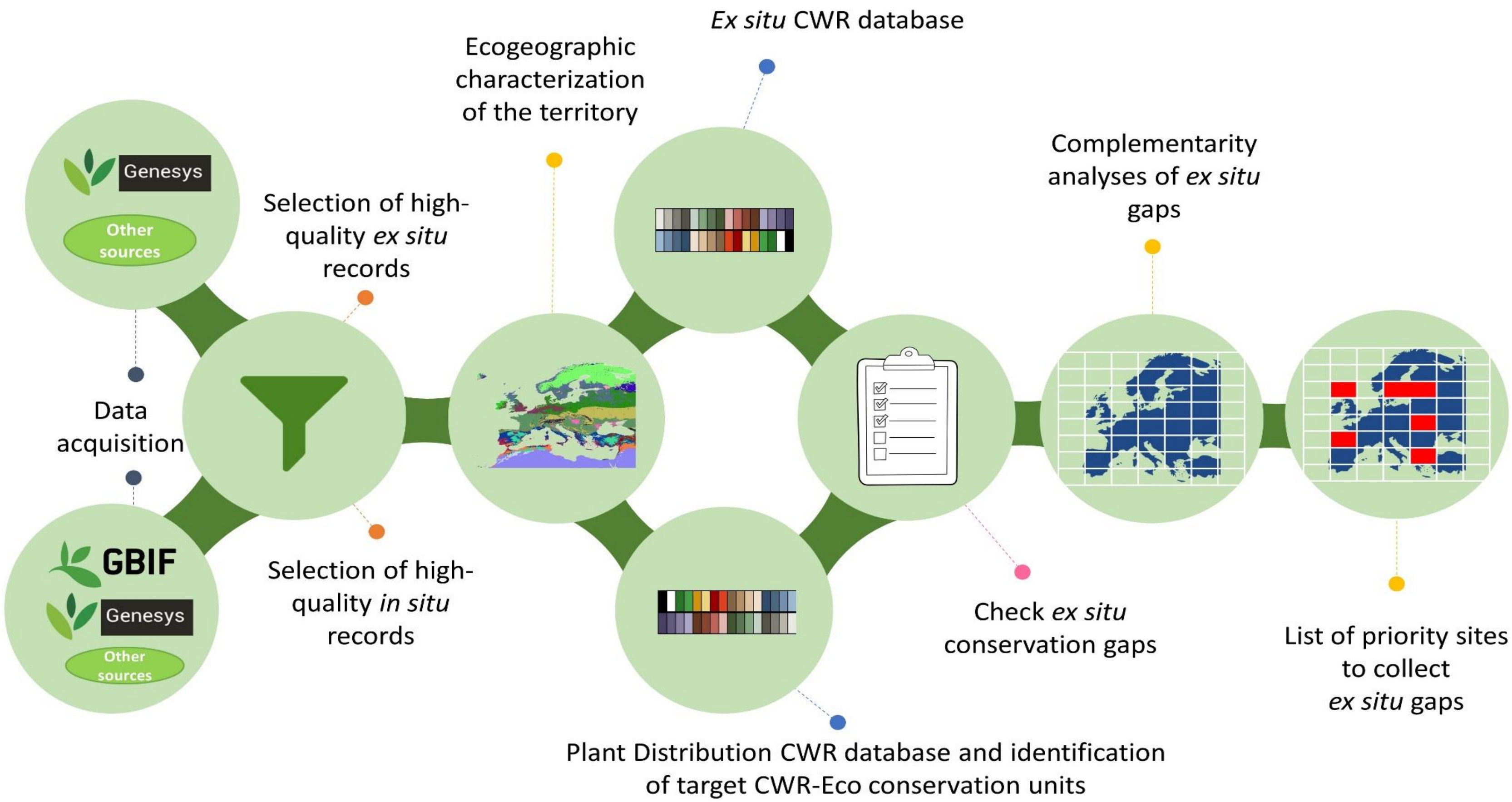

Figure 2: Process followed to obtain a priority list of sites to collect missing genetic diversity of CWR in *ex situ* genebanks.

For the generation of the database containing seed accessions conserved *ex situ* in genebanks, records from the Genesys database and other sources (mentioned above) that classified entries as *ex situ* conserved seed accessions were used. Subsequently, several filters were applied to generate a high-quality database that contained records of seed accessions obtained from wild populations with accurate and reliable georeferencing data (Table 1).

Table 1: Filters applied for the database containing natural occurrences of seed accessions conserved *ex situ* in genebanks.* Sampstat codes: 100 = wild, 110 = natural, 120 = semi-natural/wild, 200 = weedy. ** A chain text joining accession number, taxon name, coordinates and collection date was created to identify duplicates corresponding to identical entries.

Order	Description of the filter
1	Selection of accessions sampled within the geographic scope (Europe + Turkey)
2	Elimination of records with coordinates 0,0
3	Elimination of records of cultivated taxa with Sampstat codes* different from 100, 110 or 120
4	Elimination of records of non-cultivated taxa with Sampstat codes* different from 100, 110, 120, 200 or NA
5	Elimination of records of material cultivated in botanic gardens or other research institutions
6	Elimination of duplicates based on the accession number, taxon name, coordinates and collection date **
7	Elimination of records without coordinates
8	Elimination of records whose geographic coordinates do not match the reported country
9	Elimination of records in country and capital centroids, with coordinates of equal latitude / longitude or with coordinates corresponding to research institutions
10	Elimination of records whose coordinates fall in the sea

2.4 Ecogeographic Land Characterization map

The characterization of the genetic diversity of the populations was performed using an Ecogeographic Land Characterization (ELC) Map (Parra-Quijano *et al.* 2008), for Europe and Asiatic Turkey, that classifies the territory according to bioclimatic, edaphic and geophysical variables. Considering that different environmental pressures impose divergent genetic diversity of adaptive value along the distribution area of a species, if a territory is classified in various ecogeographical categories according to the environmental variables operating in each place, we could expect that populations occurring in sites with different ecogeographical categories would present different genetic adaptations. Under this proxy, we can identify different subsets of populations within a given CWR that potentially possess maximum genetic differentiation.

To build the map, a grid of points separated 50 km from each other was created for Europe and Asiatic Turkey using a script developed in R statistical environment (R Core Team 2020). Each point was ecogeographically characterized using the SelecVar tool of CAPFITOGEN3 (Parra-Quijano 2020) in its local mode (R based). The analysis included 67 bioclimatic variables, 35 edaphic variables and 20 geophysical variables (Annex B). The resolution of the variables extracted in each point was 2.5 arc-min (around 5x5 km). The selection of the variables for the construction of the ELC map was made using the SelecVar tool of CAPFITOGEN3. The importance of variables was estimated using a Random Forest (RF) algorithm, which uses two different indexes – the Mean Decrease Accuracy (MDA) and Mean Decrease Gini (MDG) – to classify the variables (Cutler *et al.* 2007). A bivariate correlation analysis checked the correlations existing among variables in each component (bioclimatic, edaphic, geophysical). The 15 variables of each component with the highest MDA values were initially selected. Then, within each component, correlated variables (Pearson correlation coefficient >|0.50| and p-value <0.05) with the lowest MDA values were removed.

The variables selected for each component were introduced as parameters for the generation of the ELC map, which potentially pictures the different environments shaping plant genetic diversity in Europe. The ELC map for Europe and Asiatic Turkey was generated using the ELCmapas tool of CAPFITOGEN3 (Parra-Quijano 2020) in its local version (R based), with a resolution of 2.5 arc-min (around 5x5 km). The maximum number of clusters per component was set to six and the number of groups in the clustering analyses was determined through the elbow method, as recommended for large extensions of territory (Parra-Quijano *et al.* 2016).

2.5 Creation of CWR-Eco units as indicators of genetic diversity of CWR taxa

Once the ELC map for Europe and Asiatic Turkey was developed, the genetic diversity of CWR taxa under analyses was estimated by joining the population occurrences with the ecogeographic categories assigned to the sites where they occur. The combinations of each CWR taxon with each of the ELC categories corresponding to the sites where their populations occur were designated as the target conservation units and were generically named "CWR-Eco". The different CWR-Eco represent the potentially different genetic diversity contained by the populations of a given CWR. For instance, if a CWR occurs in four different ELC categories, we could expect that populations inhabiting those different environments would show different patterns of genetic diversity of adaptive value (Figure 3). Thus, the conservation objective is not to preserve one (or more) populations of each CWR taxon, but at least one population of each CWR-Eco. The assignment of the populations (plant distribution database) or accessions (*ex situ* database) to the ELC categories of the map was performed with the Representa tool of CAPFITOGEN3 (Parra-Quijano 2020), in its local R-based mode. Subsequently, for each record, the taxon name was joined to the ELC category corresponding to the site where the population is found, creating a new field with the corresponding CWR-Eco. ELC categories "NA" or "0" were excluded from this process, as these categories indicate lack of data for all or some variables.

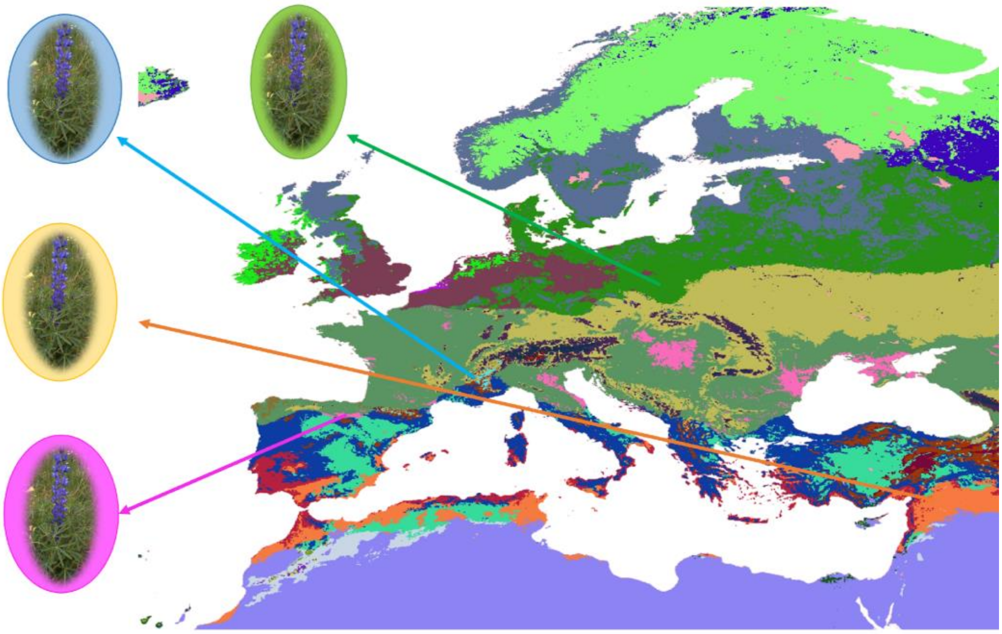

Figure 3: ELC map of the territory of study and a hypothetical example describing the estimation of genetic diversity of adaptive value in a target CWR taxon. If a given CWR taxon occurs in different environments, we expect the different populations inhabiting those environments to hold different genetic diversity of adaptive value. The combination of a CWR taxon with each of the ecogeographic categories where its populations are found constitute the conservation target. We generically name each of the conservation targets CWR-Eco units.

2.6 Hotspot and complementarity analyses for *in situ* conservation

The hotspot analysis involves estimating the richness of target conservation units (number of CWR taxa or number of CWR-Eco units) in different subsets of the territory, which is, in this study, the protected areas that conform the Natura 2000 network, or 50x50 km cells in a grid that covers the study area.

A complementarity analysis is an iterative process that allows to identify the minimum number of sites required to protect the maximum number of targeted conservation units (Rebelo 1994). During this process, the algorithm selects the place with the highest number of target conservation units (in our study, CWR-Eco). In a second step, the CWR-Eco contained in the first place are taken out from the analysis and the algorithm searches for the next site encompassing the maximum number of CWR-Eco. This process is repeated until all CWR-Eco are covered.

2.6.1 Natura 2000 network

The hotspot analysis performed at the taxon level in earlier stages of the Farmer's Pride project to assess the suitability of the Natura 2000 network (N2000) for the *in situ* conservation of CWR (Rubio Teso *et al.* 2020b) was repeated with the data of the final updated *in situ* database. In this way, the new taxa and occurrences incorporated in the *in situ* database were also reflected in the final results. To do that, we first extracted from the CWR *in situ* database those records occurring in the countries where N2000 is present. The N2000 polygons used in the former analysis were also updated by the European Environment Agency including new sites in the 2019 version. Thus, the updated GIS layer for the N2000 sites was downloaded from the European Environment Agency website (https://www.eea.europa.eu/data-and-maps/data/natura-

11/natura-2000-spatial-data/natura-2000-shapefile-1, last accessed 2021/07/20). This layer contains polygons for Sites of Community Importance (SCI) designated under the Habitats Directive and Special Protection Areas (SPAs) and designated under the Birds Directive (D 2009/147/EC) (European Commission 2009). With the updated *in situ* database for CWR priority taxa and the updated layer of N2000 sites, the hotspots identification of CWR taxon richness in N2000 was repeated by calculating CWR taxon richness in each N2000 site. This process was carried out in R statistical environment (R Core Team 2020) using the dplyr (Wickham *et al.* 2019), sp (Pebesma and Bivand 2005), sf (Pebesma 2018), raster (Hijmans 2019), rgdal (Bivand *et al.* 2019), maptools (Bivand and Lewin-Koh 2019), and rgeos (Bivand and Rundel 2019)packages. The resulting richness map was visualized in ArcGIS v.10.5 (ESRI 2016).

2.6.2 Europe and Asiatic Turkey

The identification of CWR-Eco hotspots of *in situ* populations in Europe and Asiatic Turkey was performed by calculating the richness of CWR-Eco in a grid of 50x50 km cells covering the targeted area. This process was carried out in R statistical environment (R Core Team 2020) using the dplyr (Wickham *et al.* 2019), sp (Pebesma and Bivand 2005), sf (Pebesma 2018), raster (Hijmans 2019), rgdal (Bivand *et al.* 2019), maptools (Bivand and Lewin-Koh 2019), and rgeos (Bivand and Rundel 2019) packages. The resulting richness grid was visualized in ArcGIS v.10.5 (ESRI 2016).

In this analysis, the protected areas registered at the World Database of Protected Areas (WDPA) and those included in the Natura 2000 network were both considered to ensure that all protected areas with available spatially explicit data about their borders were covered. The file with the polygons of the WDPA was downloaded in April 2021 from the website 'Explore the World's Protected Areas' (protectedplanet.net), at the European regional level protectedplanet.net/region/EU (last accessed 2020/07/20).

The shapefile polygons from N2000 and WDPA obtained were merged into a single shapefile that contained all available protected areas in Europe and Turkey, using the function 'join vector layers' in QGIS v.3.18.2-Zürich (QGIS.org 2021). All areas in the resulting shapefile were considered for the complementarity analysis.

The *in situ* complementarity analysis was performed with the plant distribution database containing the CWR-Eco information and a shapefile with N2000 and WDPA sites, using the R script developed for the local mode of the Complementa tool of CAPFITOGEN3 (Parra-Quijano 2020).

The CWR-Eco combinations not found in any protected area, were incorporated into a new complementarity analysis, using a grid of 5 arc-min cells (around 10x10 km). Again, the local mode (R based) of Complementa tool of CAPFITOGEN3 was used to perform this analysis. The purpose of this analysis was to find the minimum set of 5 arc-min cells that would cover all the CWR-Eco combinations that were not found in the network of protected areas of Europe and Asiatic Turkey.

2.7 *Ex situ* conservation of CWR and identification of CWR-Eco units in genebanks

Prior to the filtering process, the CWR taxa found in the raw *ex situ* database were checked against those of the European CWR priority list. In this way we obtained the list of priority CWR that have at least one accession preserved in genebanks, regardless of the availability of geographic coordinates.

Subsequently, to obtain the CWR-Eco represented by European priority CWR accessions stored in genebanks, the filtered *ex situ* database was used. The European priority CWR that have accessions (with coordinates) stored in genebanks were combined with the ecogeographic categories corresponding to the localities where the accessions were originally collected from natural populations, and the total number of combinations was recorded.

2.8 Complementarity analyses for optimal *ex situ* collection design

To identify CWR-Eco gaps of accessions in genebanks, we compared the list of CWR-Eco found in the *ex situ* database against the CWR-Eco found in the plant distribution database. CWR-Eco found in the plant distribution database but not in the *ex situ* database, were the target units for collecting missions. In order to identify suitable places for *ex situ* surveying, we performed a complementarity analysis using a grid of 50x50 km cells and considered the different CWR-Eco contained in each cell. The analysis was performed using the local mode (R based) of the Complementa tool of CAPFITOGEN3 (Parra-Quijano 2020).

3. Results

3.1 European priority CWR

The European priority list of CWR includes 863 taxa related to human and animal food crops (485 species and 378 subspecific taxa). The taxa belong to 102 genera and are related to 108 human food crops and 102 forage and fodder crops, most of them cereals or legumes, although other important families, such as Rosaceae, Brassicaceae or Solanaceae, are also represented. The complete list of taxa is available in Annex C. Further details are found in Rubio Teso *et al.* (2020a).

3.2 Databases of CWR locations and *ex situ* accessions

The addition of new data to the Plant Distribution (PD) database previously described in Rubio Teso *et al.* (2020a) resulted in the incorporation of 36,350 new records, including 96 new taxa, and one new country that was not previously represented. The final PD database thus contains 3,130,581 occurrences for 712 priority taxa. This means that the PD database contains occurrence records for 82.5% of the taxa included in the European CWR priority list. Priority taxa included in the PD database and the number of occurrence records available for each taxon is shown in Annex C.

The raw *ex situ* database contained 136,393 accessions for 457 priority taxa before filtering for duplicates, and entries without or with inaccurate geographic coordinates. Accordingly, circa 53% of the European CWR priority taxa are represented in this database. The elimination of duplicates and records without coordinates resulted in a final *ex situ* database containing 75,393 accessions for 358 priority taxa collected in 41 countries within the geographic scope of the study. Annex C provides information concerning the number of accessions with geographic coordinates stored in genebanks for each European priority CWR.

3.3 Ecogeographic Land Characterization map

The non-correlated variables selected using the Random Forest algorithm to generate the ELC map were five, one bioclimatic (annual mean temperature), three edaphic (topsoil pH, soil organic carbon density and topsoil salinity) and one geophysical variable (annual solar radiation). The resulting ELC map had 37 categories, which represent the potential different adaptive scenarios in Europe and Asiatic Turkey (Figure 4).

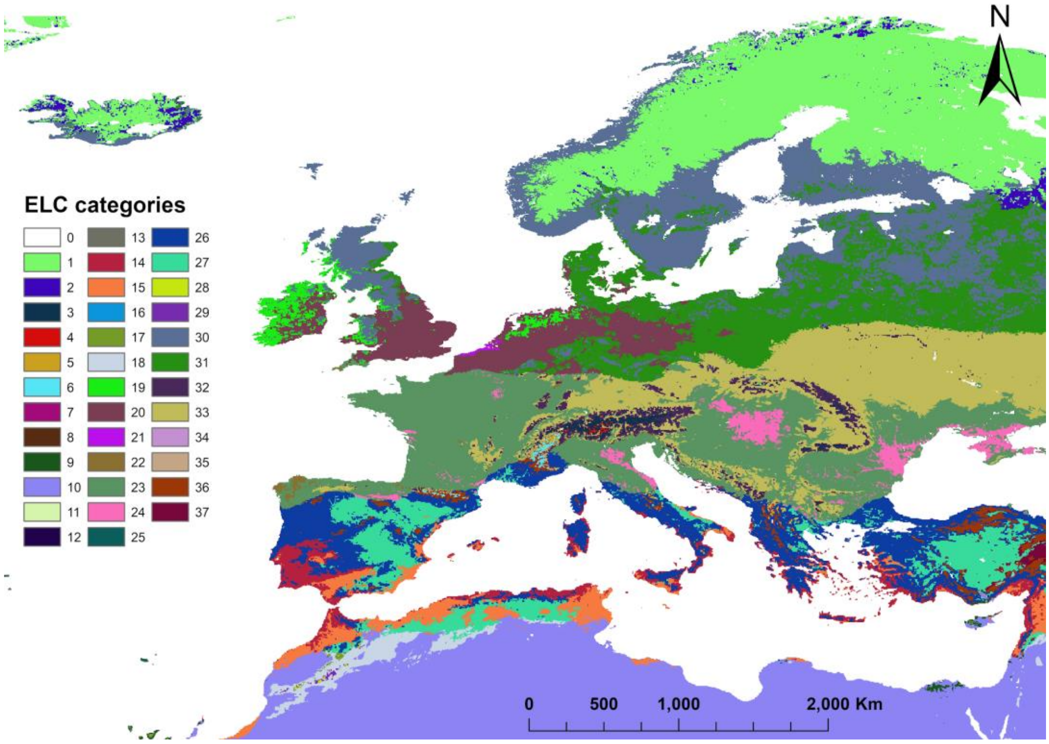

Figure 4: Ecogeographic Land Characterization (ELC) map for Europe and Turkey classifying the territory in 37 ecogeographic categories.

3.4 Creation of CWR-Eco units as indicators of genetic diversity of CWR taxa

A total of 6470 CWR-Eco units were obtained by combining the European priority CWR taxa with the ELC categories corresponding to the sites where their populations are found. These 6470 CWR-Eco units constitute the conservation targets for which there is available data in the PD database. They include the different priority CWR for which we have occurrence data as well as the number of populations that we wished to conserve for each taxon, using CWR-Eco as a proxy of genetic diversity.

3.5 Hotspot and complementarity analyses for *in situ* conservation

3.5.1 Natura 2000 network

An initial assessment of the potential of the Natura 2000 network for the *in situ* conservation of CWR was published by Rubio Teso *et al.* (2020b). The results shown here provide an update of this analysis after the incorporation of additional data to the PD database and the use of the last version of GIS layers with the polygons of the N2000 sites.

The intersection of the PD database with the countries where N2000 network is present resulted in 2,933,820 occurrence records corresponding to 652 European CWR priority taxa. When a gap analysis was performed with this subset of the PD database against the polygons of the N2000 network, 409,642 occurrence records, corresponding to 593 European CWR priority taxa, were found within the N2000 network (Figure 5). This represents 91% of the European priority CWR with available data.

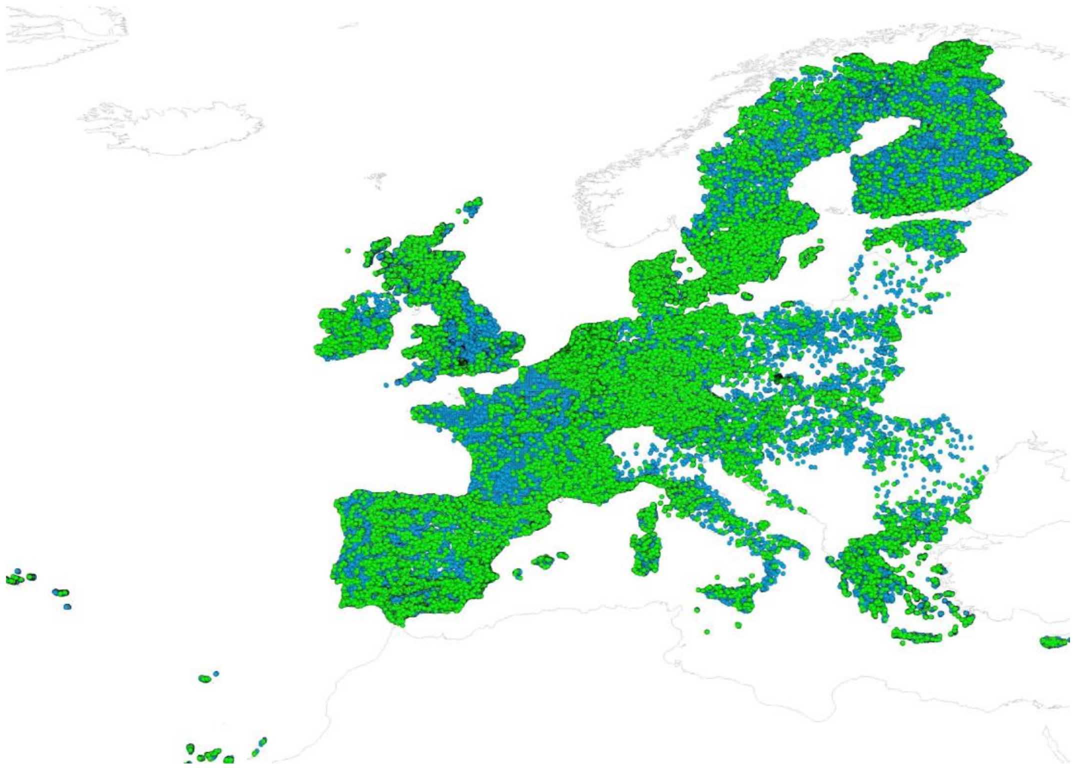

Figure 5: Populations of priority CWR occurring in the Natura 2000 network. Green dots represent CWR populations found in Natura 2000 sites. Blue dots represent CWR populations outside Natura 2000 sites.

The hotspot analysis presented in Figure 6 showed that 32 N2000 sites contain populations of more than 100 priority CWR taxa and that approximately one third of the sites (8673 sites) contain at least one priority CWR taxon. The average number of priority CWR taxa per site was 17. The top 50 N2000 sites regarding CWR taxa richness (Figure 7) are presented in Annex D, including information about the number of CWR taxa and the number of population occurrences. Two sites have the highest richness and host 118 different CWR taxa, one in Spain (Serra d'Espadá, sitecode ES0000468) and one in France (Pays des Couzes, sitecode FR8312011). From a population occurrence perspective, the site with the highest number of occurrences (4615 for 96 taxa), from the above-mentioned top 50, is found in The Netherlands (Veluwe, sitecode NL3009017), followed by four sites in Spain, The Netherlands and France with more than 3000 populations (site codes ES0000449, NL2014067, NL2014038 and FR2402001, respectively).

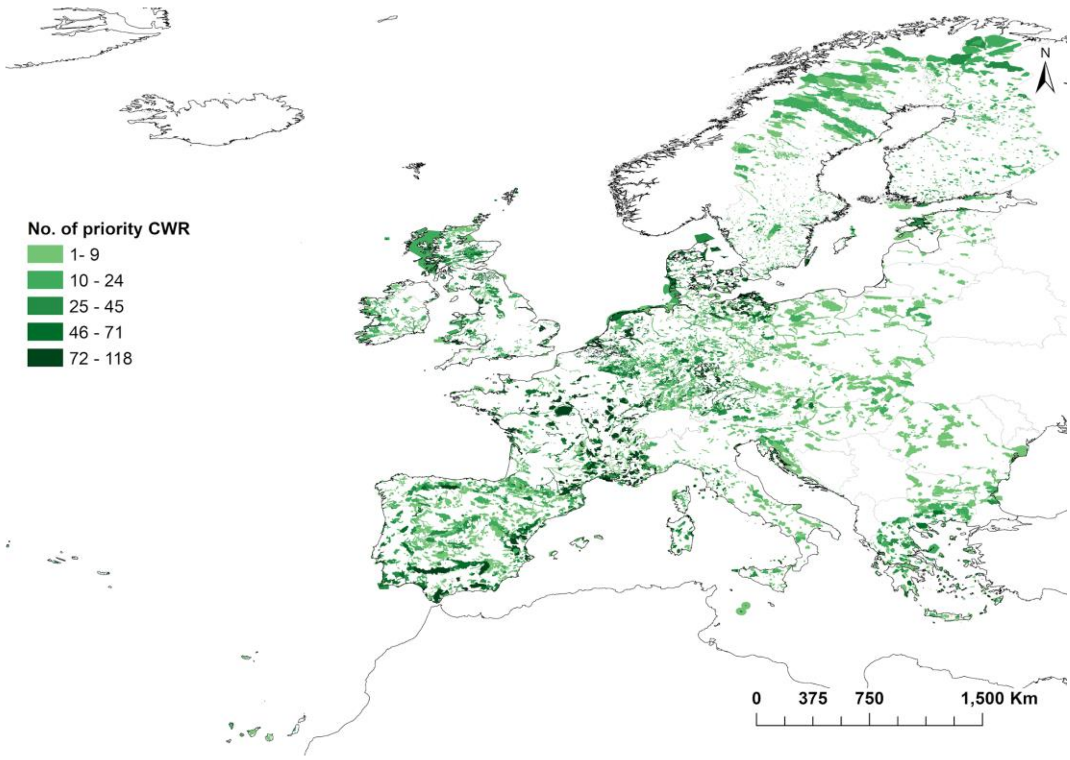

Figure 6: Richness of crop wild relative priority taxa in Natura 2000

3.5.2 Europe and Asiatic Turkey

The CWR-Eco hotspot analysis for Europe and Asiatic Turkey performed in 50x50 km cells with the CWR-Eco *in situ* database showed the distribution of CWR-Eco richness along the territory of study (Figure 8). The 50x50 km cell containing the greatest number of CWR-Eco units – 673, around 10% of the total CWR-Eco units under analysis – was found in France, close to the Italian and Austrian borders. Overall, several hotspots areas with more than 200 different CWR-Eco units were found, mostly in western countries (e.g. Spain, France, Germany, UK, Sweden or Finland among others). It is also worth mentioning that the relevant CWR-Eco diversity found in Azores islands has a high representation of CWR-Eco in a very reduced area. Thus, three 50x50 cells that host 235, 195 and 193 CWR-Eco each were found.

On the contrary, eastern countries – except for Greece and some areas of Cyprus, Ukraine, Russia or Turkey) showed lower values of CWR-Eco richness per 50x50 km cell.

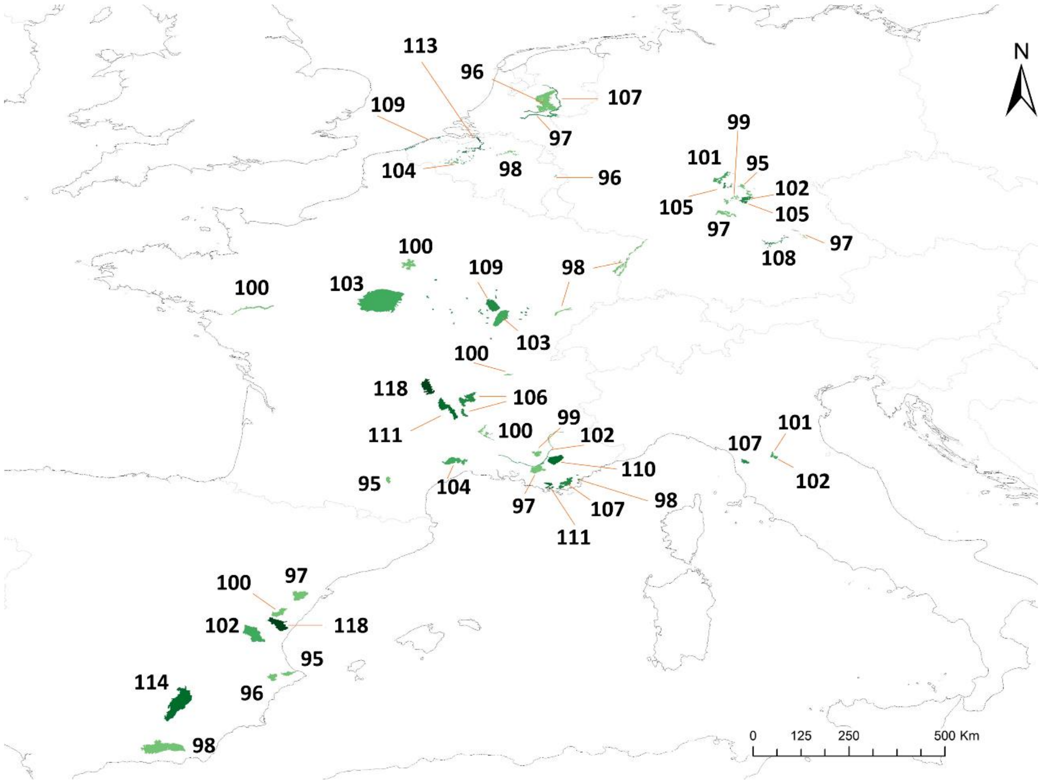

Figure 7: Top 50 Natura 2000 sites according to richness of priority CWR taxa. The figures in the map depict the number of priority CWR taxa found at each site.

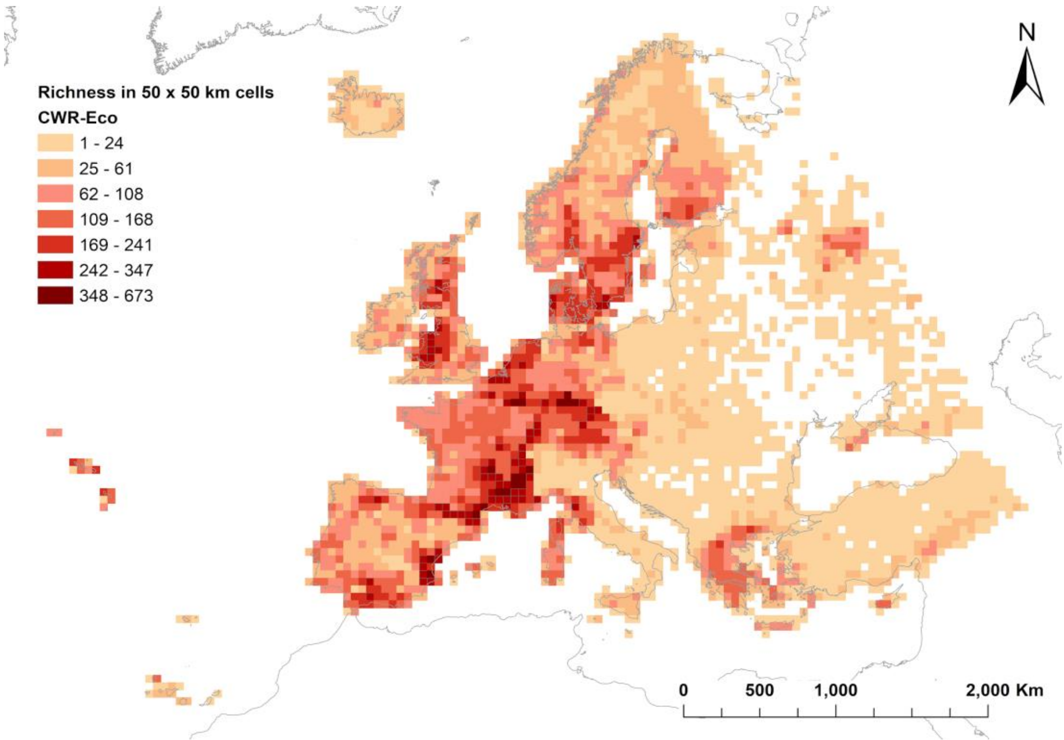

Figure 8: CWR-Eco richness in Europe and Turkey measured in 50 x 50 km cells.

The merging of the Natura 2000 sites and the protected areas of the World Database of Protected Areas, resulted in 171,342 protected areas within the geographic scope of the Farmer's Pride project.

The gap and complementarity analyses for the *in situ* conservation in protected areas showed that 825 sites (0.48% of the total network) distributed across 34 countries provide coverage of 5046 *in situ* CWR-Eco (c. 78% of the target conservation units), corresponding to 629 priority CWR taxa (around 88.3% of the priority CWR taxa with available data) (Figures 9 and 10). The N2000 network contributes 550 sites to this selection and other protected areas registered in the WDPA provide 275 sites. The top 50 protected areas selected with the complementarity analysis provide coverage of approximately 50% of the targeted CWR-Eco (3220 CWR-Eco). The protected area with the highest number of CWR-Eco (512) is Spessart (Ehemals Schutzzone), a national landscape protection area located in Germany. The next two top sites are two regional nature parks (Baronnies Provençales and Ballons Des Vosges) located in France, adding 237 and 166 new CWR-Eco. The fourth place, adding 161 new CWR-Eco is a Special Protection Birds Area (Serra d'Espadà) belonging to the Natura 2000 network in Spain. 446 of the 825 selected areas only add one new CWR-Eco to the selection of sites, although in these areas other CWR-Eco already included in other previously selected protected areas are probably represented. The first top 50 sites and the number of new CWR-Eco that contribute are shown in Annex E.

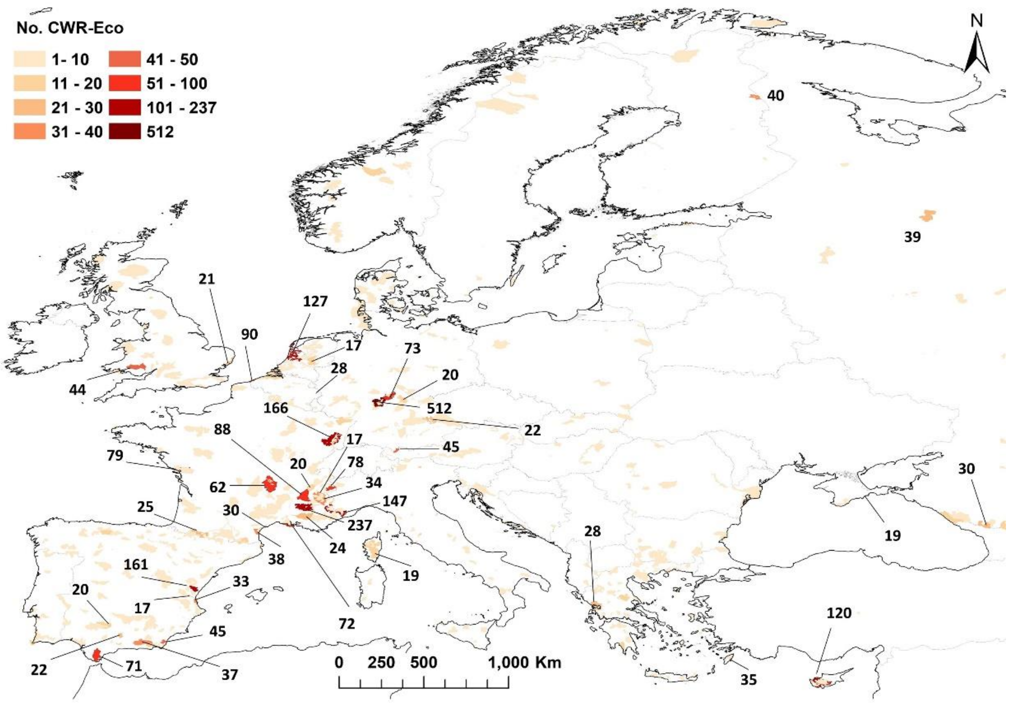

Figure 9: Protected areas and number of CWR-Eco in continental Europe plus Asiatic Turkey after the complementary analysis. The figures depict the number of CWR-Eco combinations found in the top 50 selected sites.

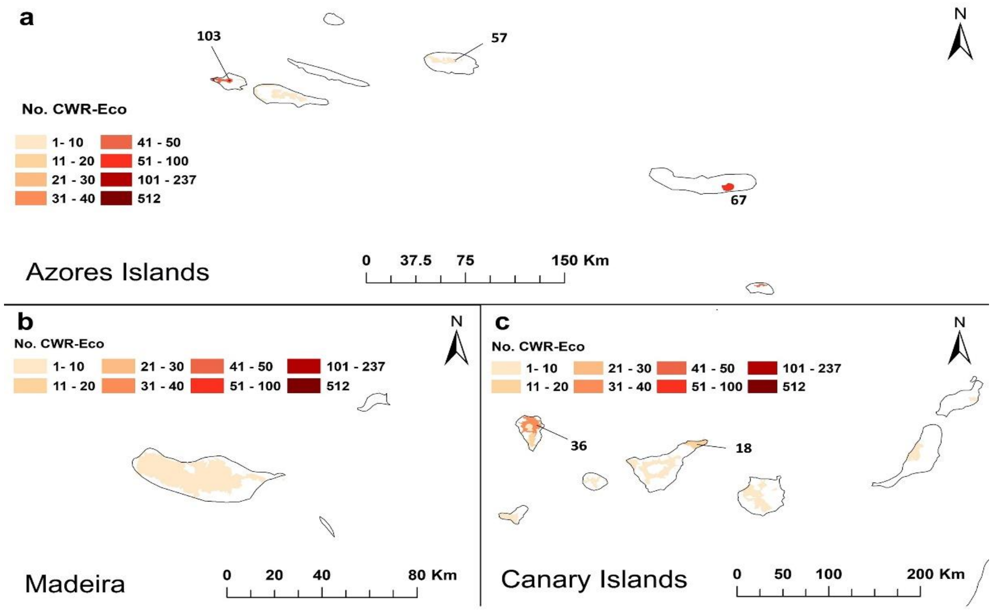

Figure 10: Protected areas and number of CWR-Eco in a) Azores Islands and b) Madeira and c) Canary Islands, after the complementary analysis. Number of CWR-Eco combinations for those among first 50 selected sites indicated.

The subsequent complementarity analysis, using a grid of 10x10 km cells to take into account those CWR-Eco not found in protected areas, targeted 1424 CWR-Eco for all taxa under analysis (712 taxa). At least one CWR-Eco for each of these taxa was not found in any protected area and 83 taxa did not have any of their CWR-Eco in protected areas, according to the available data. These 1424 CWR-Eco were represented by 5015 occurrence records in 44 countries. The results showed that 853 cells (10x10 km) would be necessary to include all targeted CWR-Eco (Figures 11, 12, 13 and 14). Although Turkey has more than 2400 protected areas that cover around 7% of the territory (Küçük and Ertürk 2013), the low number of protected areas (18) recorded in WDPA makes Turkey one of the countries with the highest number of selected cells through this complementarity analysis. Spain and Germany also show a high number of selected cells. The 10x10 cell with the greatest number of CWR-Eco (47) is found in France, partially overlapping with a N2000 site (Adrets de Tarentaise, sitecode FR8201777 and selected as one of the complementarity protected areas, with two CWR-Eco) (Figure 11). Nine 10x10 km cells host more than 10 different CWR-Eco complementary combinations each (Figures 11, 12, 13 and 14), which makes 175 CWR-Eco that would be complementary to those already found in protected areas. To cover half of the CWR-Eco diversity found outside protected areas, 179 cells would be needed. 495 cells only add just one new CWR-Eco (although they may contain other CWR-Eco already found in the previously selected protected areas and cells). Again, it is worth mentioning the high diversity of CWR-Eco found in Azores and Canary Islands (Figure 14) selected in the first places of the complementarity analyses. For instance, the Canary Islands host one cell with 23 CWR-Eco, in La Palma which partially overlaps a N2000 protected area selected in the previous complementarity analysis with 36 different CWR-Eco combinations (Summits and cliffs of North La Palma, sitecode ES0000114).

Figure 11: Selected 10x10 km cells and number of CWR-Eco in western continental Europe after the complementary analysis to cover missing CWR-Eco diversity not found in protected areas. Cells with more than 10 different CWR-Eco combinations are indicated with the number of different CWR-Eco that they contain.

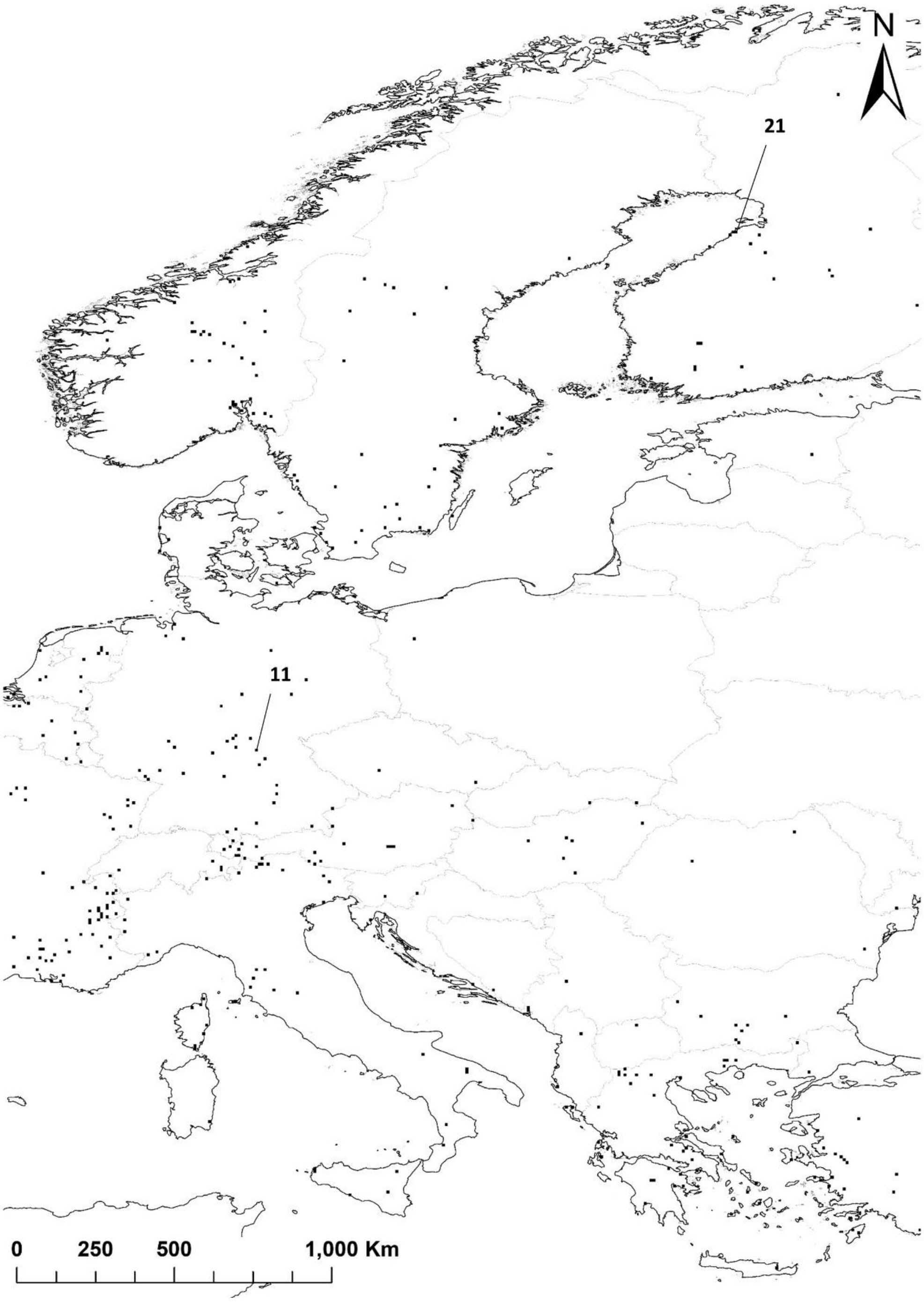

Figure 12: Selected 10x10 km cells and number of CWR-Eco in central continental Europe after the complementary analysis to cover missing CWR-Eco diversity not found in protected areas. Cells with more than 10 different CWR-Eco combinations are indicated with the number of different CWR-Eco that they contain.

Figure 13: Selected 10x10 km cells and number of CWR-Eco in eastern continental Europe and Asiatic Turkey after the complementary analysis to cover missing CWR-Eco diversity not found in protected areas. Cells with more than 10 different CWR-Eco combinations are indicated with the number of different CWR-Eco that they contain.

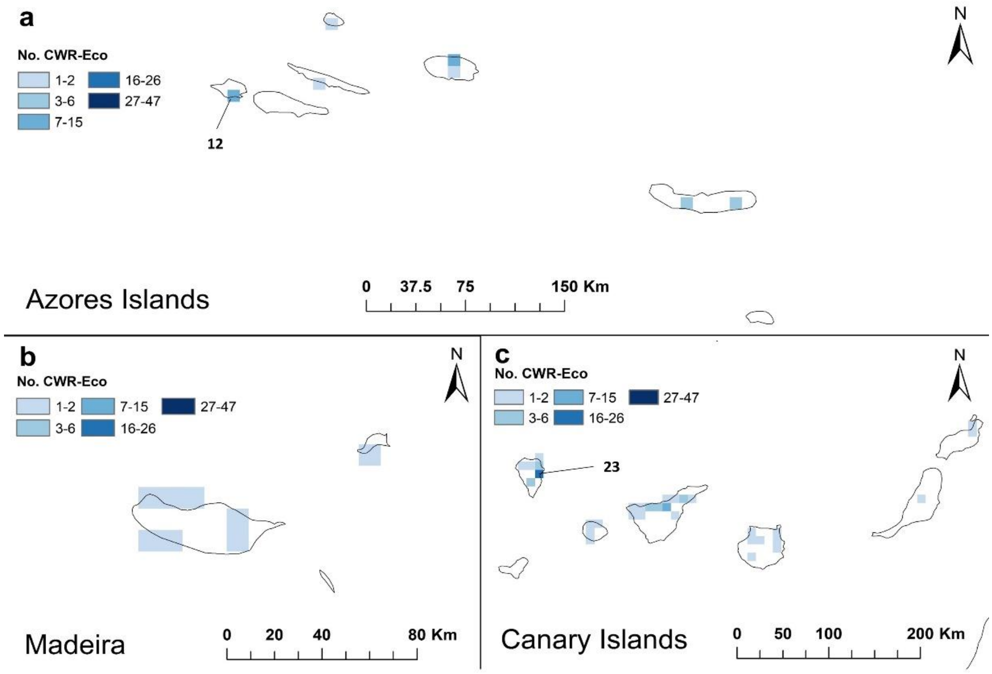

Figure 14: Selected 10x10 km cells and number of CWR-Eco in a) Azores Islands, b) Madeira and c) Canary Islands after the complementarity analysis to cover missing CWR-Eco diversity not found in protected areas. Cells with more than 10 different CWR-Eco combinations are indicated with the number of different CWR-Eco that they contain.

When a full picture of the sites selected through the complementarity analyses – both in protected areas or in 10x10 km cells – is taken, we observe that many of the 10x10 km areas are close or adjacent to selected protected areas, especially in countries with higher density of selected protected areas (Figures 15 and 16).

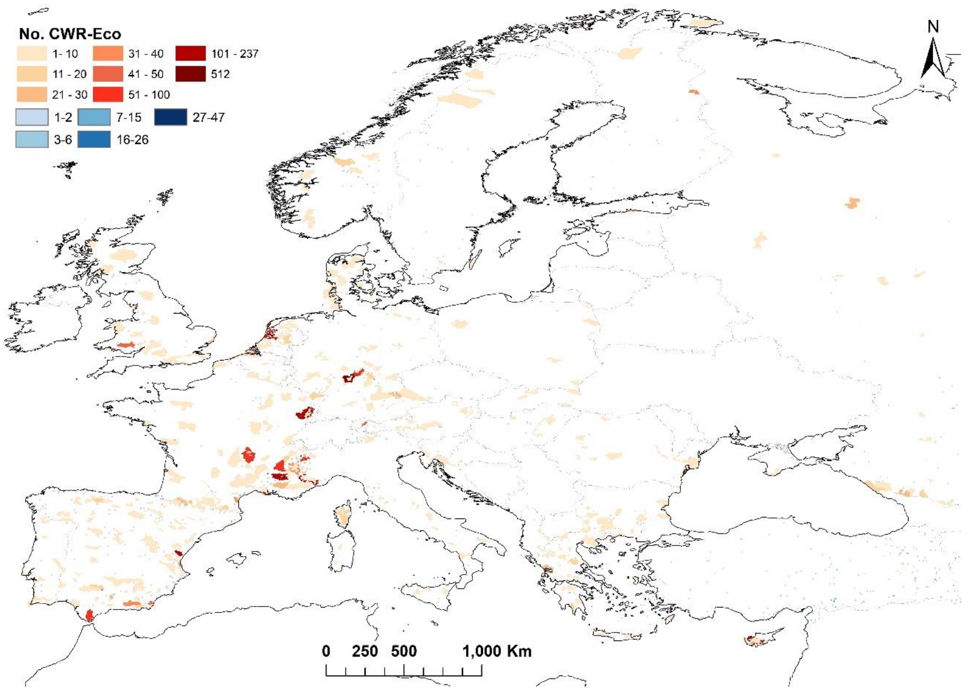

Figure 15: Map of all the protected areas (red) and 10x10 km cells (blue) selected through complementarity analyses that cover all 6470 CWR-Eco targeted in the study (continental Europe plus Turkey).

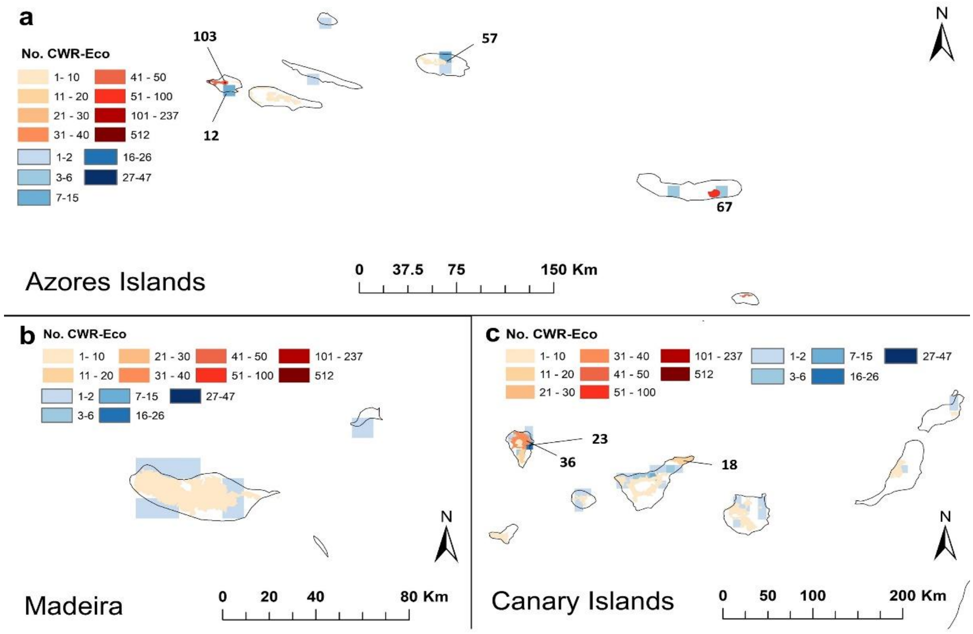

Figure 16: Map of all the protected areas (red) and 10x10 km cells (blue) selected through complementarity analyses that cover all 6470 CWR-Eco targeted in the study (continued). a) Azores Islands, b) Madeira and c) Canary Islands.

3.6 *Ex situ* conservation of CWR and CWR-Eco units in genebanks

53% of the CWR priority taxa (*i.e.*, 457 out of 863) have at least one accession stored in genebanks. From this, 41% (358 taxa) have accessions with geographic coordinates. Combining these accessions with their corresponding ecogeographic categories, 1906 of the 6470 CWR-Eco conservation targets identified in the PD database are currently conserved *ex situ* in genebanks. 1607 accessions were not included in this analysis as they were collected in locations where some of the environmental information was missing and therefore could not be assigned to a valid ELC category.

3.7 Complementarity analyses for optimal *ex situ* collection design

From the 6470 CWR-Eco found in the PD database, 1906 are represented in genebank collections. Therefore, 4564 CWR-Eco (corresponding to 712 taxa and 903,723 occurrence records) are missing in the genebanks and constitute the *ex situ* conservation target. This means that all 712 priority CWR taxa included in the PD database are missing at least one CWR-Eco combination.

The complementarity analysis showed that seed collection in 734 50x50 km cells is necessary to fully cover the germplasm corresponding to the missing 4564 CWR-Eco (Figure 17). Collecting missions would need to take place across all the territory (Figure 17). Seed collecting in the top 100 50x50 km cells of the ranking would likely provide around 73% of the targeted germplasm (3350 CWR-Eco). At the bottom of the ranking there are 360 50x50 km cells that would only provide one new CWR-Eco.

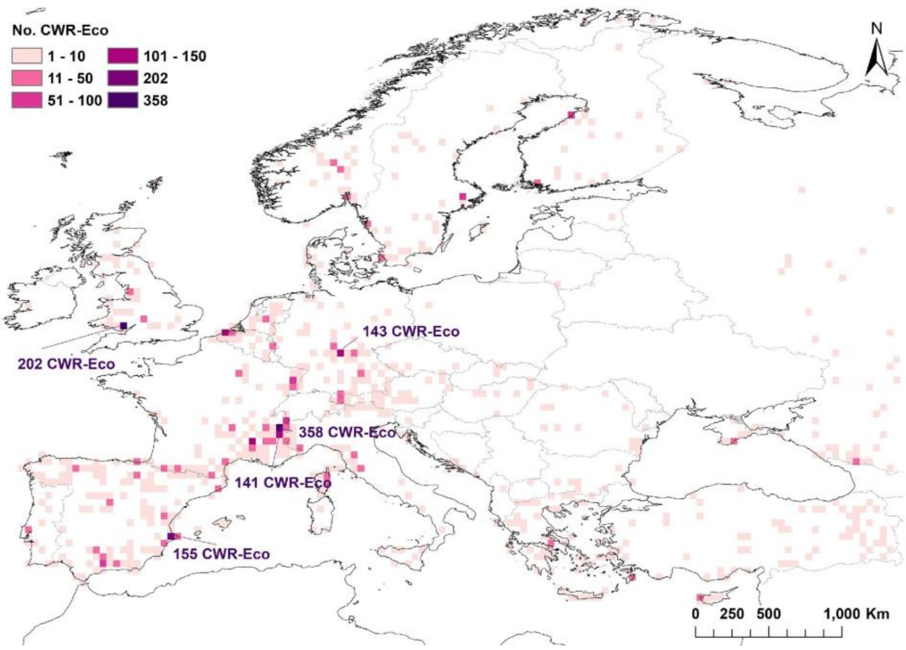

Figure 17: Complementarity analysis shows the 734 50x50 km cells, extended across all the territory, where collecting missions have to be carried out to conserve *ex situ* the targeted 4564 CWR-Eco. The legend with the different colors indicates the range of CWR-Eco that can be found in each cell. The five cells with the greatest number of CWR-Eco are depicted with the number of CWR-Eco that they contain.

4. Discussion

The concept for *in situ* conservation of crop wild relatives in Europe (Maxted *et al.,* 2003) provides a comprehensive strategy for effective *in situ* conservation of CWR genetic resources native to Europe. The strategy proposes two core levels of CWR conservation strategy planning, one at the national level and another at the regional level. The development of a CWR conservation strategy at the European regional level requires the identification of the CWR native to Europe that are of greatest importance at this regional level. The European priority CWR list presented in this project provides the essential initial step on which the strategy at the regional level in founded. According to the concept, this list is the reference upon which the Regional priority CWR populations (regional MAWPS) should be based. Similarly, this list serves as the reference basis for the rest of the analyses conducted in this study.

4.1 Databases of CWR locations and *ex situ* locations

The Plant Distribution (PD) database of CWR locations containing 3,130,581 occurrences for 712 taxa of the European priority CWR list is the largest and more complete database of European CWR occurrence up to date. Therefore, it is the best source information available that can be used to conduct a CWR conservation analysis at the European level. Yet, at the same time, it has some limitations that it is important to take into account when assessing the results of the analyses performed in this study:

1. The spatial distribution of the database occurrence records is biased with a significantly lower number of occurrence records in most Eastern European countries and Italy.
2. The database contains occurrence records of 712 of the 863 taxa of the European CWR priority list. This means that there are 151 CWR taxa for which it has not been possible to obtain any distribution data.

The main reason for the biased spatial distribution of the database occurrence records relies on the fact that the main source of information of the database is the GBIF database. This database is, practically, the only one available containing global (and European level) distribution of wild plant species and puts together the information coming from most national and international initiatives. The countries with lower representation of occurrence records in the database correspond to the countries in Europe that do not participate in the GBIF network. Although some of these countries possess national databases of plant occurrences, the access to them is restricted and the attempts to obtain information have been largely unsuccessful due to lack of response from the contacts and/or to the impossibility to conduct data downloads.

The lack of any occurrence records regarding 151 taxa is probably due to several causes. The main one is probably that the distribution of many of these taxa occurs in the European countries that do not participate in the GBIF network. Threatened taxa and narrowly endemic taxa have also constrained access to their locations and their occurrence records are not uploaded to global databases, to protect them. Nomenclatural changes and taxonomic inconsistencies are also responsible for other taxa having fewer than expected available records. In the case of subspecific taxa, many occurrence records are not determined to the subspecific level and, therefore, their distribution data are seriously limited. Collectors will often name to an identifiable taxon, so if the subspecific taxon is not the type subtaxon then they will identify to that subspecies or variety, but if it is the type subtaxon then they just identify to species level only, which means type subtaxa are always under-represented and this is the case for the dataset collated.

Finally, lack of digitized information may account for many collections being excluded from the analysis. These records may have location data, but their digitization and georeferencing was not feasible with the time and resources available. Even though this obviously impacted the analysis and limited the results interpretation.

In essence, the current PD database contains information on over 80% of the European CWR priority taxa. Further collation of the occurrence data that are not yet in the database involves individual searches, taxon by taxon, and country by country, contacting local botanists, and accessing the information available in public herbaria and national scientific literature. This work also faces the obstacles associated with the use of different Floras of reference in each country, which are based on different taxonomic views and to the literature available in the different national languages. We spent a considerable amount of time conducting individual searches for several endemic taxa and were able to add some new taxa to the PD database, but were able to address just a relatively small amount of the taxa that were not initially included in the database. Needless to say that the real distribution of these taxa far exceeds all the records that could possibly be obtained in this way. Although some European countries (e.g. UK and Germany) have established plant survey schemes that systematically cover all the territory, most countries are very far from implementing a similar scheme.

One conclusion derived from this situation is the need to issue a recommendation to European authorities concerning the establishment of a European wide plant survey scheme that georeferences plant populations and systematically covers all the territory, and that all this information is digitized and made publicly available in a database. This biodiversity infrastructure is essential to be able to conduct fine-tuned analyses for the conservation and management of CWR diversity and plant biodiversity in general.

The *ex situ* database contains 136,393 accessions for 457 priority taxa mainly obtained from the Genesys database. In this case, the information is not spatially biased because practically all European countries contribute data through the EURISCO database, which then feeds the Genesys database. The gathered *ex situ* database does not contain information about all the accessions of the priority CWR conserved in genebanks because the country providers have not been able to upload yet all the information from each country. In any case, the work is in progress and the outlook to be able to get more complete information in the near future is good, simply by updating the search in the Genesys database. Perhaps, the biggest limitation of the *ex situ* database is the fact that many accessions do not have high quality georeferencing data. The completion of this information in historic accessions is difficult and sometimes impossible. In this sense, it is advisable that future germplasm collecting expeditions make an effort to gather high quality georeferencing data and include it in the genebank databases.

In addition to the analyses performed in the present study, the gathered Plant Distribution and *ex situ* databases are an essential infrastructure of plant genetic resources information that can be used in many other studies related to the conservation and use of European CWR. An example of this is the predictive characterization work described in the document 'Identifying *in situ* areas with useful adaptive traits' (Rubio Teso *et al.* 2020c) where the PD database was the data source for conducting the predictive characterization analyses with the selected CWR case studies.

4.2 Ecogeographic Land Characterization map: creation of CWR-Eco units as indicators of genetic diversity of CWR taxa

The Ecogeographic Land Characterization map generated in this study has classified the European and Asiatic Turkey territory in 37 categories, which constitute a proxy indicator for the between-population genetic diversity that may be present in the targeted priority CWR. Ideally, it would be advisable to characterize the genetic diversity of each taxon by conducting extensive genetic diversity assessments using genomic and other molecular markers. However, this is currently impossible to achieve and such assessments only exist for a handful of species. Previous discussions on how to capture the genetic diversity of a given species and how many populations to sample have provided varying recommendations, such as sampling a minimum of five populations, 50 populations or 35% of the populations, depending on different assumptions and particular characteristics of the species (Hamrick and Godt 1989; Center for Plant Conservation 1991; Brown and Marshall 1995; Guerrant Jr. *et al.* 2004; Meyer *et al.* 2012; Whitlock *et al.* 2016). The CWR-Eco approach, instead of recommending a fixed number of populations to sample, it provides a variable number that is associated to the different ecogeographical categories where each species is distributed. Despite the inaccuracies that may be generated from the use of this proxy, this is probably the best available tool that we currently have to estimate the genetic diversity of hundreds of taxa across the territory.

The combination of targeted CWR taxa with the ecogeographic categories of the ELC map corresponding to the sites where their populations are found rendered a total of 6470 CWR-Eco units which constitute the conservation targets for this study. The use of these conservation targets constitutes a considerable advance in CWR conservation as the conservation targets accommodate to the main purpose of conserving, not the CWR taxa as such, but the genetic diversity that they contain, to be used in plant breeding. In this sense, the identification of hotspots of CWR-Eco combinations provides an excellent framework for the proposal of sites where to establish genetic reserves of crop wild relatives or where to collect missing CWR diversity in genebanks.

4.3 Hotspot and complementarity analyses for *in situ* conservation

The gap analysis and hotspot analysis performed for the European countries that participate in the Natura 2000 network showed that the Natura 2000 network provides a very effective infrastructure for the *in situ* conservation of CWR as its protected areas cover populations from at least 91% of the European priority CWR with available data. Considering the deficit of population occurrences for some relevant countries, such as Italy, the coverage of targeted taxa may be in fact greater. The hotspot analysis provided a ranked list with the Natura 2000 sites that hold the greatest number of priority CWR taxa. Specifically, the top 50 sites with the greatest number of priority CWR taxa (Annex D) point to a series of protected areas that could be taken under consideration for further analyses concerning the identification and designation of genetic reserves where regional priority CWR populations can be found. Further and more detailed information about the potential use of the Natura 2000 network for the *in situ* conservation of European priority CWR can be found in Rubio Teso et al. 2020b. Although this approach is entirely top down it can provide an effective starting point for the 'European network for *in situ* conservation and sustainable use of plant genetic resources' (Maxted *et al.*, 2013). However, it is important to appreciate that: (a) additional sites would also be added to the European Network by national PGR programmes following national gap analysis, and (b) individual protected area authorities may also wish to nominate their sites / populations to join the European Network because they believe in the concept of CWR *in situ* conservation and wish their site to contribute and have kudos associated with the additional ecosystem services provision. The data of this updated analysis has been transferred to the web tool 'CWR in European Protected Areas', developed in the context of the Farmer's Pride project and available at ecpgr.cgiar.org/crop-wild-relatives-in-natura-2000. This tool is oriented to managers of protected areas in Europe wishing to find out which CWR (CWR) are likely to occur in the protected areas they manage. It allows to search for all protected areas in which a CWR taxon occurs, providing the number of populations in each one, and to discover which CWR taxa occur in named protected areas.

The main analysis performed for all the territory under study (Europe and Asiatic Turkey) was carried out using the previously mentioned CWR-Eco conservation target units. The CWR-Eco hotspot analysis identified, in a grid of 50x50 km cells, the cells with the greatest number of CWR-Eco. Although the complementarity analysis with protected areas provides the most efficient way of configuring a network that conserves the targeted CWR-Eco in the least number of protected areas, the cells with more than 200 different CWR-Eco found in many western European countries are also good candidate areas for further analyses and evaluation in the process of identification and designation of genetic reserves where regional priority CWR populations can be found.

The gap analysis carried out to assess the *in situ* genetic conservation in Europe and Asiatic Turkey showed that protected areas also provide a good coverage of CWR genetic diversity at this level (c. 78% of the target CWR-Eco conservation units and 88.3% of the priority CWR taxa with available data). The 825 protected areas identified with the complementarity analysis, that cover 100% of the CWR-Eco conservation targets, but especially the top 50 protected areas selected which provide coverage to around 50% of the targeted CWR-Eco (Annex E), are also relevant candidate sites to consider in further analyses for the designation of genetic reserves for the conservation of regional CWR populations. The same can be said for the 853 10x10 km cells outside protected areas that would cover all the CWR-Eco that were not found in the assessed protected areas (and, especially the 179 cells that would cover around 50% of these CWR-Eco).

An additional limiting factor to consider in these analyses is that the list of protected areas obtained by adding the Natura 2000 sites to the list of protected areas available in the World Database of Protected Areas (WDPA) does not include all the protected areas present in Europe and Asiatic Turkey. Once again this is probably because some countries do not provide information about their protected areas to the global databases (*i.e.*, for example, Turkey only includes 18 PA in the World Database of Protected Areas). The availability of the polygons corresponding to the borders of the protected areas non-accounted at this stage would significantly reduce the number of CWR-Eco that would have to be covered outside protected areas.

How should we treat the lists of different locations that have been presented as potential candidates for the designation of genetic reserves? First, it is important to take into account the limitations of the Plant Distribution database mentioned in section 4.2, which constitute the basis of this analysis. The lack of information about the occurrence of some priority CWR taxa and the biased information with little occurrence data for some countries means that there are probably other sites that contain a relevant number of targeted CWR-Eco and even a number of new priority CWR-Eco that escaped from our analyses. The analysis results presented are the best possible with the time and resources currently available, but we are still very far from having a complete census of wild populations of the European priority CWR. Yet they are the first European continental CWR analysis for genetic diversity and can be used to make initial conservation decisions. From the results provided above, it would be of greatest interest to focus further studies on candidate sites on the results of the complementarity analyses with protected areas and with sites outside protected areas, because they provide the most efficient way of maximizing the conservation of CWR diversity with a minimum of sites. Within those sites, the ones that occupy the first positions in the rankings are, at the same time, the ones that provide the greatest number of CWR-Eco within the minimum number of sites, so they should be priority within the set. Sites occurring in protected areas are evidently preferable over sites outside protected areas because the implementation of genetic reserves is likely to be much easier, less costly and provide greater long-term security for the CWR populations included (Maxted 2003).

4.4 *Ex situ* conservation of CWR and CWR-Eco units in genebanks: complementarity analyses for optimal *ex situ* design

The *ex situ* database provides a balanced, representative picture of the regional priority CWR and CWR-Eco presently conserved in genebanks. The gap analysis against the PD database clearly points to the germplasm that still needs to be collected to conserve *ex situ* a representative account of CWR genetic diversity. The results of the complementarity analysis are the basis for the design of an efficient CWR germplasm collecting that should be carried out through close coordination among the different national genebanks that could be involved in this initiative. Thus, the most practical approach in terms of economic cost and bureaucracy would be for the national genebanks to take responsibility for collecting in the sites selected through the complementarity analysis that occur in their own country. Within those sites, those that occupy the upper positions in the ranking of the complementarity analysis would be the ones that would be collected in the first place, because they will render the highest benefit/cost ratio.

For any given 50x50 km cell selected for priority collecting potentially containing, in some cases, over 100 CWR-Eco, we can consider further criteria for prioritizing among the occurring CWR-Eco. One essential criterion will clearly be phenology, and particularly, the time for fruit ripening, so each expedition will be focused on collecting the CWR-Eco that have ripe fruits and viable seeds at that time. Another criterion may involve the representativity of the ecogeographical categories within the distribution of each priority CWR. Thus, collecting in the rarest ecogeographical categories for each priority CWR should be prioritized for *ex situ* conservation, because these sites are more vulnerable to be lost. On the contrary, the CWR-Eco that are more frequent for each CWR taxon are less prioritary because the greater number of populations occurring *in situ* guarantees their future persistence. Finally, the impact of climate change should be assessed and taken into account before any collecting mission is implemented so the collection of those taxa with the most vulnerable populations should be prioritized.

4.5 *In situ* networking recommendations

In conclusion, the present study provides the following *in situ* networking recommendations:

1. The focus of CWR conservation is not CWR taxa diversity, but the genetic diversity contained in these taxa. Therefore, the conservation targets should be established accordingly. The CWR-Eco conservation units are the best available approach to define the targets to be used in the conservation of CWR diversity.
2. The network of protected areas of Europe and Asiatic Turkey, and specifically the Natura 2000 network, constitute a great infrastructure for the *in situ* conservation of CWR, as it covers most of the pre-defined conservation targets, and active *in situ* conservation is much simpler, less costly and more sustainable to perform in them. Therefore, the *in situ* network of CWR should be mostly based in the establishment of genetic reserves within existing protected areas.
3. The best candidate sites for the establishment of genetic reserves for the *in situ* conservation of regional CWR priority populations, according to the currently available data, are those derived from the rankings of the complementarity analyses performed in this study.
4. Protected areas occupying the first positions in the ranking of the complementarity analyses should be the ones that should be prioritized for further evaluation including relative susceptibility to climate change, as they contain the largest number of CWR-Eco (Annex E).
5. Further evaluation should include on-site verification of the presence of the priority CWR taxa populations in each of the selected candidate protected areas, and an assessment of their population size and conservation status. Protected area managers and authorities should be contacted to determine the capacity and motivation to engage in active conservation of CWR.
6. European authorities should be approached to request the creations of a European wide plant survey infrastructure that systematically collates occurrence data homogeneously over all the territory, digitizes the information and makes it available to the public. This would enormously improve the knowledge of plant biodiversity in Europe and would enable much better fine tuned analyses for the *in situ* conservation of CWR in Europe.
7. Nominated European Network sites should also meet the Iriondo *et al.* (2008) and Maxted *et al.* (2016) criteria for joining the European Network and populations should me managed using the CWR Management Guidelines (Iriondo *et al.* 2021).

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Annex A: List of new taxa added to the *in situ* database with data from the Global Biodiversity Information Facility and corresponding citations

R identifier	Scientific name	Citation	Comments
443329	*Agrostis capillaris* L. subsp. *capillaris*	GBIF.org (31 August 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.5rkr27	
468028	*Agrostis gigantea* subsp. *glaucescens* (Widén) Valdés & H. Scholz	GBIF.org (31 August 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.gxzwyz	
492914	*Allium pardoi* Loscos	GBIF.org (17 August 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.tgsrtq	
443465	*Avena fatua* L. subsp. *fatua*	GBIF.org (3 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.rt8j97	
297363	*Brassica repanda* subsp. *glabrescens* (Poldini) Gómez Campo	GBIF.org (4 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.5rab3k	
403770	*Carthamus tenuis* (Boiss. & C. I. Blanche) Bornm.	GBIF.org (4 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.fsbp8a	
550327	*Crambe feuillei* A. Santos ex Prina & Mart.-Laborde	GBIF.org (4 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.9dqndv	
295057	*Crambe gomeraea* H. Christ	GBIF.org (4 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.nzafb3	
444491	*Dactylis glomerata* subsp. *ibizensis* Stebbins & D. Zohary	GBIF.org (7 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.5pr9hu	
444501	*Dactylis glomerata* subsp. *reichenbachii* (Dalla Torre & Sarnth.) Stebbins & D. Zohary	GBIF.org (7 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.aqjgg3	
345133	*Daucus carota* subsp. *hispidus* (Ball) Heywood	GBIF.org (12 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.5ud9km	
444673	*Echinochloa crus-galli* subsp. *hispidula* (Retz.) Honda	GBIF.org (12 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.det4m3	
444761	*Elymus trachycaulus* (Link) Shinners subsp. *trachycaulus*	GBIF.org (12 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.d6k3fb	

R identifier	Scientific name	Citation	Comments
445698	*Elytrigia intermedia* (Host) Nevski subsp. *intermedia*	GBIF.org (12 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.aez8n3	
445937	*Festuca ovina* L. subsp. *ovina*	GBIF.org (14 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.hnp6hg	
467437	*Festuca ovina* subsp. *molinieri* (Litard.) Foggi & J. Müll.	GBIF.org (14 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.q87xkf	
467440	*Festuca ovina* subsp. *ruprechtii* (Boiss.) Tzvelev	GBIF.org (14 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.yyt6my	
467443	*Festuca ovina* subsp. *supina* (Schur) Oborný	GBIF.org (15 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.uxms3a	
467514	*Festuca rubra* subsp. *juncea* (Hack.) K. Richt.	GBIF.org (15 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.pdywth	
451977	*Ficus carica* L.	GBIF.org (19 August 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.syqyhd	
451860	*Juglans ailantifolia* Carrière	GBIF.org (16 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.ffnf6s	
539686	*Lens culinaris* subsp. *odemensis* (Ladiz.) M. E. Ferguson & al.	GBIF.org (16 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.9xs9gu	
466978	*Leymus racemosus* subsp. *sabulosus* (M. Bieb.) Tzvelev	GBIF.org (16 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.hbmc4n	
321386	*Linum corymbiferum* Desf.	GBIF.org (16 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.2ywjvv	
321552	*Linum hirsutum* subsp. *anatolicum* (Boiss.) Hayek	GBIF.org (1 October 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.z8vkvm	
321632	*Linum hirsutum* subsp. *glabrescens* (Rochel) Soó	GBIF.org (16 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.ewk863	
545993	*Lolium perenne* L. subsp. *perenne*	GBIF.org (16 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.g7jjeq	
540574	*Lotus corniculatus* subsp. *frondosus* Freyn	GBIF.org (16 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.kbs6r6	

R identifier	Scientific name	Citation	Comments
469844	*Malus sylvestris* subsp. *praecox* (Pall.) Soó	GBIF.org (16 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.4a56q8	
537014	*Medicago lupulina* var. *cupaniana* (Guss.) Boiss.	GBIF.org (16 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.w4zceq	
467661	*Ochlopoa annua* (L.) H. Scholz	GBIF.org (19 August 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.5j7vx5	GBIF considers *O. annua* a synonym of *Poa annua* L.
467662	*Ochlopoa annua* (L.) H. Scholz subsp. *annua*	GBIF.org (16 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.y5jdvy	
467666	*Ochlopoa annua* subsp. *raniglumis* (E. Fröhner) H. Scholz & Valdés	GBIF.org (16 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.v3ds6a	
521552	*Olea europaea* subsp. *guanchica* P. Vargas & al.	GBIF.org (16 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.xqk7ta	
466417	*Panicum miliaceum* subsp. *agricolum* H. Scholz & Mikoláš	GBIF.org (16 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.fw2bd4	
447546	*Panicum miliaceum* subsp. *ruderale* (Kitag.) Tzvelev	GBIF.org (16 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.jvban4	
467800	*Poa trivialis* subsp. *latifolia* (Schur) Portal	GBIF.org (16 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.j58rdf	
448636	*Saccharum spontaneum* subsp. *aegyptiacum* (Willd.) Hack.	GBIF.org (17 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.a8gk9g	
448638	*Schedonorus arundinaceus* (Schreb.) Dumont subsp. *arundinaceus*	GBIF.org (17 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.9ch9yn	
467940	*Schedonorus arundinaceus* subsp. *mediterraneus* (Hack.) H. Scholz & Valdés	GBIF.org (17 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.q8x9nm	
466997	*Secale cereale* subsp. *ancestrale* Zhuk.	GBIF.org (17 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.qfvt94	
466472	*Setaria italica* subsp. *moharia* (Alef.) R. A. W. Herrm.	GBIF.org (17 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.y8k3rb	

R identifier	Scientific name	Citation	Comments
466477	*Setaria italica* subsp. *pycnocoma* (Steud.) De Wet	GBIF.org (17 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.yzc7st	
449469	*Solanum sisymbrifolium* Lam.	GBIF.org (17 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.y7yabj	
448786	*Trisetum flavescens* subsp. *corsicum* (Rouy) Cif. & Giacom.	GBIF.org (17 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.pt8wxu	
437461	*Vaccinium macrocarpon* Aiton	GBIF.org (17 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.9njm59	
540540	*Vicia melanops* Sibth. & Sm. var. *melanops*	GBIF.org (17 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.xzw7bp	
552123	*Vitis acerifolia* Raf.	GBIF.org (17 September 2020) GBIF Occurrence Download https://doi.org/10.15468/dl.gtdrcu	

Annex B: Initial list of variables, units and sources used in the generation of the ELC map

Type of variable	Variable code	Variable description	Variable unit	Source	Link to source
Bioclimatic	bio_1	Annual Mean Temperature	°C	Worldclim	http://worldclim.org
Bioclimatic	bio_2	Mean Diurnal Range (Mean of monthly (max temp - min temp))	°C	Worldclim	http://worldclim.org
Bioclimatic	bio_3	Isothermality (BIO2/BIO7) (* 100)	-	Worldclim	http://worldclim.org
Bioclimatic	bio_4	Temperature Seasonality (standard deviation *100)	-	Worldclim	http://worldclim.org
Bioclimatic	bio_5	Max Temperature of Warmest Month	°C	Worldclim	http://worldclim.org
Bioclimatic	bio_6	Min Temperature of Coldest Month	°C	Worldclim	http://worldclim.org
Bioclimatic	bio_7	Temperature Annual Range (BIO5-BIO6)	°C	Worldclim	http://worldclim.org
Bioclimatic	bio_8	Mean Temperature of Wettest Quarter	°C	Worldclim	http://worldclim.org
Bioclimatic	bio_9	Mean Temperature of Driest Quarter	°C	Worldclim	http://worldclim.org
Bioclimatic	bio_10	Mean Temperature of Warmest Quarter	°C	Worldclim	http://worldclim.org
Bioclimatic	bio_11	Mean Temperature of Coldest Quarter	°C	Worldclim	http://worldclim.org
Bioclimatic	bio_12	Annual Precipitation	mm	Worldclim	http://worldclim.org
Bioclimatic	bio_13	Precipitation of Wettest Month	mm	Worldclim	http://worldclim.org
Bioclimatic	bio_14	Precipitation of Driest Month	mm	Worldclim	http://worldclim.org
Bioclimatic	bio_15	Precipitation Seasonality (Coefficient of Variation)	mm	Worldclim	http://worldclim.org
Bioclimatic	bio_16	Precipitation of Wettest Quarter	mm	Worldclim	http://worldclim.org
Bioclimatic	bio_17	Precipitation of Driest Quarter	mm	Worldclim	http://worldclim.org
Bioclimatic	bio_18	Precipitation of Warmest Quarter	mm	Worldclim	http://worldclim.org
Bioclimatic	bio_19	Precipitation of Coldest Quarter	mm	Worldclim	http://worldclim.org
Bioclimatic	prec_1	Mean Precipitation January	mm	Worldclim	http://worldclim.org
Bioclimatic	prec_2	Mean Precipitation February	mm	Worldclim	http://worldclim.org
Bioclimatic	prec_3	Mean Precipitation March	mm	Worldclim	http://worldclim.org
Bioclimatic	prec_4	Mean Precipitation April	mm	Worldclim	http://worldclim.org
Bioclimatic	prec_5	Mean Precipitation May	mm	Worldclim	http://worldclim.org
Bioclimatic	prec_6	Mean Precipitation June	mm	Worldclim	http://worldclim.org

Type of variable	Variable code	Variable description	Variable unit	Source	Link to source
Bioclimatic	prec_7	Mean Precipitation July	mm	Worldclim	http://worldclim.org
Bioclimatic	prec_8	Mean Precipitation August	mm	Worldclim	http://worldclim.org
Bioclimatic	prec_9	Mean Precipitation September	mm	Worldclim	http://worldclim.org
Bioclimatic	prec_10	Mean Precipitation October	mm	Worldclim	http://worldclim.org
Bioclimatic	prec_11	Mean Precipitation November	mm	Worldclim	http://worldclim.org
Bioclimatic	prec_12	Mean Precipitation December	mm	Worldclim	http://worldclim.org
Bioclimatic	tmax_1	Max Temperature January	°C	Worldclim	http://worldclim.org
Bioclimatic	tmax_2	Max Temperature February	°C	Worldclim	http://worldclim.org
Bioclimatic	tmax_3	Max Temperature March	°C	Worldclim	http://worldclim.org
Bioclimatic	tmax_4	Max Temperature April	°C	Worldclim	http://worldclim.org
Bioclimatic	tmax_5	Max Temperature May	°C	Worldclim	http://worldclim.org
Bioclimatic	tmax_6	Max Temperature June	°C	Worldclim	http://worldclim.org
Bioclimatic	tmax_7	Max Temperature July	°C	Worldclim	http://worldclim.org
Bioclimatic	tmax_8	Max Temperature August	°C	Worldclim	http://worldclim.org
Bioclimatic	tmax_9	Max Temperature September	°C	Worldclim	http://worldclim.org
Bioclimatic	tmax_10	Max Temperature October	°C	Worldclim	http://worldclim.org
Bioclimatic	tmax_11	Max Temperature November	°C	Worldclim	http://worldclim.org
Bioclimatic	tmax_12	Max Temperature December	°C	Worldclim	http://worldclim.org
Bioclimatic	tmean_1	Mean Temperature January	°C	Worldclim	http://worldclim.org
Bioclimatic	tmean_2	Mean Temperature February	°C	Worldclim	http://worldclim.org
Bioclimatic	tmean_3	Mean Temperature March	°C	Worldclim	http://worldclim.org
Bioclimatic	tmean_4	Mean Temperature April	°C	Worldclim	http://worldclim.org
Bioclimatic	tmean_5	Mean Temperature May	°C	Worldclim	http://worldclim.org
Bioclimatic	tmean_6	Mean Temperature June	°C	Worldclim	http://worldclim.org
Bioclimatic	tmean_7	Mean Temperature July	°C	Worldclim	http://worldclim.org
Bioclimatic	tmean_8	Mean Temperature August	°C	Worldclim	http://worldclim.org
Bioclimatic	tmean_9	Mean Temperature September	°C	Worldclim	http://worldclim.org

Type of variable	Variable code	Variable description	Variable unit	Source	Link to source
Bioclimatic	tmean_10	Mean Temperature October	°C	Worldclim	http://worldclim.org
Bioclimatic	tmean_11	Mean Temperature November	°C	Worldclim	http://worldclim.org
Bioclimatic	tmean_12	Mean Temperature December	°C	Worldclim	http://worldclim.org
Bioclimatic	tmin_1	Min Temperature January	°C	Worldclim	http://worldclim.org
Bioclimatic	tmin_2	Min Temperature February	°C	Worldclim	http://worldclim.org
Bioclimatic	tmin_3	Min Temperature March	°C	Worldclim	http://worldclim.org
Bioclimatic	tmin_4	Min Temperature April	°C	Worldclim	http://worldclim.org
Bioclimatic	tmin_5	Min Temperature May	°C	Worldclim	http://worldclim.org
Bioclimatic	tmin_6	Min Temperature June	°C	Worldclim	http://worldclim.org
Bioclimatic	tmin_7	Min Temperature July	°C	Worldclim	http://worldclim.org
Bioclimatic	tmin_8	Min Temperature August	°C	Worldclim	http://worldclim.org
Bioclimatic	tmin_9	Min Temperature September	°C	Worldclim	http://worldclim.org
Bioclimatic	tmin_10	Min Temperature October	°C	Worldclim	http://worldclim.org
Bioclimatic	tmin_11	Min Temperature November	°C	Worldclim	http://worldclim.org
Bioclimatic	tmin_12	Min Temperature December	°C	Worldclim	http://worldclim.org
Edaphic	depth_rock	Depth to bedrock (R horizon) up to 200 cm	cm	Soilgrids	https://soilgrids.org
Edaphic	r_horizon	Probability of occurrence of R horizon	%	Soilgrids	https://soilgrids.org
Edaphic	ref_depth	Reference depth of the soil unit	Code	HWS Database	http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/
Edaphic	sodicity	Sodic soil grade	grade	Soilgrids	https://soilgrids.org
Edaphic	t_awc1	Available soil water capacity (volumetric fraction) for h1 – topsoil	%	Soilgrids	https://soilgrids.org
Edaphic	t_awc2	Available soil water capacity (volumetric fraction) for h2 – topsoil	%	Soilgrids	https://soilgrids.org
Edaphic	t_awc3	Available soil water capacity (volumetric fraction) for h3 – topsoil	%	Soilgrids	https://soilgrids.org
Edaphic	t_awcts	Saturated water content (volumetric fraction) for tS – topsoil	%	Soilgrids	https://soilgrids.org

Type of variable	Variable code	Variable description	Variable unit	Source	Link to source
Edaphic	t_bs	Topsoil base saturation	%	HWS Database	http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/
Edaphic	t_bulk_dens	Bulk density (fine earth) in kg / cubic-meter – topsoil	kg / cubic-m	Soilgrids	https://soilgrids.org
Edaphic	t_caco3	Topsoil calcium carbonate content	% weight	HWS Database	http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/
Edaphic	t_caso4	Topsoil calcium sulphate (gypsum) content	% weight	HWS Database	http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/
Edaphic	t_cec_clay	Topsoil CEC due to clay fraction	cmol/kg	HWS Database	http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/
Edaphic	t_cec_soil	Topsoil CEC (soil)	cmol/kg	HWS Database	http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/
Edaphic	t_cecsol	Cation exchange capacity of soil in cmolc/kg – topsoil	cmol / kg	Soilgrids	https://soilgrids.org
Edaphic	t_clay	Topsoil clay fraction	% weight	HWS Database	http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/
Edaphic	t_clay_cont	Clay content (0-2 micrometer) mass fraction in % - topsoil	%	Soilgrids	https://soilgrids.org
Edaphic	t_coarse_frag	Coarse fragments volumetric in %	%	Soilgrids	https://soilgrids.org
Edaphic	t_ece	Topsoil salinity	dS/m	HWS Database	http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/
Edaphic	t_esp	Topsoil sodicity	%	HWS Database	http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/
Edaphic	t_gravel	Topsoil gravel content	%vol.	HWS Database	http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/

Type of variable	Variable code	Variable description	Variable unit	Source	Link to source
Edaphic	t_oc	Topsoil organic Carbon	% weight	HWS Database	http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/
Edaphic	t_oc_cont	Soil organic carbon content (fine earth fraction) in g per kg	g / kg	Soilgrids	https://soilgrids.org
Edaphic	t_oc_dens	Soil organic carbon density in kg per cubic-m	kg / cubic-m	Soilgrids	https://soilgrids.org
Edaphic	t_oc_stock	Soil organic carbon stock in tons per ha	tonnes / ha	Soilgrids	https://soilgrids.org
Edaphic	t_ph_h2o	Topsoil pH (H2O)	-log(H+)	HWS Database	http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/
Edaphic	t_ph_hox	Soil pH x 10 in H2O	index*10	Soilgrids	https://soilgrids.org
Edaphic	t_ph_kcl	Soil pH x 10 in KCl	index*10	Soilgrids	https://soilgrids.org
Edaphic	t_ref_bulk	Topsoil reference bulk density	kg/dm3	HWS Database	http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/
Edaphic	t_sand	Topsoil sand fraction	% weight	HWS Database	http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/
Edaphic	t_sand_cont	Sand content (50-2000 micrometer) mass fraction in %	%	Soilgrids	https://soilgrids.org
Edaphic	t_silt	Topsoil silt fraction	% weight	HWS Database	http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/
Edaphic	t_silt_cont	Silt content (2-50 micro meter) mass fraction in %	%	Soilgrids	https://soilgrids.org
Edaphic	t_soilwater_cap	Available soil water capacity (volumetric fraction) until wilting point	%	Soilgrids	https://soilgrids.org
Edaphic	t_teb	Topsoil total exchangeable bases	cmol/kg	HWS Database	http://www.iiasa.ac.at/Research/LUC/External-World-soil-database/
Geophysical	alt	Elevation (meters above sea level)	m	Worldclim	http://worldclim.org
Geophysical	aspect	Orientation	º	Derived from SRTM DEM	NA

Type of variable	Variable code	Variable description	Variable unit	Source	Link to source
Geophysical	eastness	Eastness. Values close to 1 if East trend orientation, - 1 if West trend orientation, 0 if North or South trend		Derived from SRTM DEM	NA
Geophysical	northness	Northness. Values close to 1 if North trend orientation, - 1 if South trend, 0 if East or West trend		Derived from SRTM DEM	NA
Geophysical	POINT_X	Longitude (cell centroid)	Decimal degrees	NA	NA
Geophysical	POINT_Y	Latitude (cell centroid)	Decimal degrees	NA	NA
Geophysical	slope	Slope	º	Derived from SRTM DEM	NA
Geophysical	srad_1	Solar radiation January	MJ m-2	Worldclim2	http://worldclim.org
Geophysical	srad_2	Solar radiation February	MJ m-2	Worldclim2	http://worldclim.org
Geophysical	srad_3	Solar radiation March	MJ m-2	Worldclim2	http://worldclim.org
Geophysical	srad_4	Solar radiation April	MJ m-2	Worldclim2	http://worldclim.org
Geophysical	srad_5	Solar radiation May	MJ m-2	Worldclim2	http://worldclim.org
Geophysical	srad_6	Solar radiation June	MJ m-2	Worldclim2	http://worldclim.org
Geophysical	srad_7	Solar radiation July	MJ m-2	Worldclim2	http://worldclim.org
Geophysical	srad_8	Solar radiation August	MJ m-2	Worldclim2	http://worldclim.org
Geophysical	srad_9	Solar radiation September	MJ m-2	Worldclim2	http://worldclim.org
Geophysical	srad_10	Solar radiation October	MJ m-2	Worldclim2	http://worldclim.org
Geophysical	srad_11	Solar radiation November	MJ m-2	Worldclim2	http://worldclim.org
Geophysical	srad_12	Solar radiation December	MJ m-2	Worldclim2	http://worldclim.org
Geophysical	srad_annual	Annual solar radiation	MJ m-2	Worldclim2	http://worldclim.org

Annex C: European priority CWR with number of population occurrences with geographic coordinates, total number of seed accessions and number of seed accessions with geographic coordinates, with number of CWR-Eco units and number of countries involved

Scientific name	Population occurrences with coordinates	No. of CWR-Eco	No. of countries	Total No. seed accessions	No. of countries	No. seed accessions with coordinates	No. of CWR-Eco units	No. of countries
Aegilops bicornis (Forssk.) Jaub. & Spach	5	4	2	30	6	8	4	3
Aegilops biuncialis Vis.	989	13	13	2059	16	1625	13	13
Aegilops biuncialis subsp. *archipelagica* (Eig) Raus	0	0	0	0	0	0	0	0
Aegilops biuncialis Vis. subsp. *biuncialis*	0	0	0	0	0	0	0	0
Aegilops caudata L.	147	5	4	141	7	58	5	3
Aegilops caudata L. subsp. *caudata*	0	0	0	0	0	0	0	0
Aegilops caudata subsp. *polyathera* (Boiss.) Zhuk.	0	0	0	0	0	0	0	0
Aegilops columnaris Zhuk.	47	9	3	123	7	98	9	2
Aegilops comosa Sm.	229	6	3	469	6	322	7	3
Aegilops comosa Sm. subsp. *comosa*	40	4	2	53	3	47	4	1
Aegilops comosa subsp. *heldreichii* (Boiss.) Eig	24	4	1	0	0	0	0	0
Aegilops crassa Boiss.	3	3	2	21	5	15	5	2
Aegilops cylindrica Host	515	13	21	1180	22	798	11	20
Aegilops geniculata Roth	4153	18	15	1798	22	1310	14	17
Aegilops juvenalis (Thell.) Eig	1	1	1	17	4	3	2	1
Aegilops kotschyi Boiss.	6	4	3	20	5	14	5	3
Aegilops neglecta Bertol.	2129	14	15	2105	19	1747	12	17
Aegilops peregrina (Hack.) Maire & Weiller	57	6	4	175	8	117	8	2
Aegilops peregrina subsp. *cylindrostachys* (Eig & Feinbrun) Maire & Weiller	0	0	0	0	0	0	0	0

Scientific name	**Population occurrences with coordinates**	**No. of CWR-Eco**	**No. of countries**	**Total No. seed accessions**	**No. of countries**	**No. seed accessions with coordinates**	**No. of CWR-Eco units**	**No. of countries**
Aegilops peregrina (Hack.) Maire & Weiller subsp. *peregrina*	5	3	2	14	2	10	5	2
Aegilops speltoides Tausch	102	6	3	471	15	344	6	4
Aegilops speltoides subsp. *ligustica* (Savign.) Zhuk.	71	6	2	180	4	176	4	4
Aegilops speltoides Tausch subsp. *speltoides*	37	4	1	70	1	70	4	1
Aegilops tauschii Coss.	63	6	2	359	14	281	8	6
Aegilops tauschii Coss. subsp. *tauschii*	0	0	0	0	0	0	0	0
Aegilops triuncialis L.	2707	14	15	3586	22	2851	14	15
Aegilops triuncialis subsp. *persica* (Boiss.) Zhuk.	9	4	2	17	4	16	4	3
Aegilops triuncialis L. subsp. *triuncialis*	143	10	7	302	8	290	11	8
Aegilops umbellulata Zhuk.	164	8	4	500	9	434	7	3
Aegilops uniaristata Vis.	34	5	4	63	6	39	5	4
Aegilops vavilovii (Zhuk.) Chennav.	2	1	2	6	4	3	2	2
Aegilops ventricosa Tausch	202	8	3	138	9	61	7	5
Agropyron cimmericum Nevski	0	0	0	3	2	0	0	0
Agropyron cristatum (L.) Gaertn.	210	13	15	285	17	22	3	6
Agropyron cristatum subsp. *brandzae* (Panţu & Solacolu) Melderis	1	1	1	0	0	0	0	0
Agropyron cristatum (L.) Gaertn. subsp. *cristatum*	9	4	2	0	0	0	0	0
Agropyron cristatum subsp. *kazachstanicum* Tzvelev	0	0	0	0	0	0	0	0
Agropyron cristatum subsp. *pectinatum* (M. Bieb.) Tzvelev	95	9	8	22	3	0	0	0
Agropyron cristatum subsp. *ponticum* (Nevski) Tzvelev	0	0	0	0	0	0	0	0

Scientific name	**Population occurrences with coordinates**	**No. of CWR-Eco**	**No. of countries**	**Total No. seed accessions**	**No. of countries**	**No. seed accessions with coordinates**	**No. of CWR-Eco units**	**No. of countries**
Agropyron cristatum subsp. *puberulum* (Steud.) Tzvelev	0	0	0	0	0	0	0	0
Agropyron cristatum subsp. *sabulosum* Lavrenko	0	0	0	0	0	0	0	0
Agropyron cristatum subsp. *sclerophyllum* Tzvelev	0	0	0	0	0	0	0	0
Agropyron dasyanthum Ledeb.	1	1	1	7	1	1	1	1
Agropyron desertorum (Link) Schult.	16	6	5	49	5	2	1	1
Agropyron tanaiticum Nevski	3	2	1	5	2	0	0	0
Agrostis capillaris L.	106003	24	32	671	28	480	13	22
Agrostis capillaris L. subsp. *capillaris*	2253	14	4	0	0	0	0	0
Agrostis capillaris subsp. *oreophila* (O. Schwarz) Soják	0	0	0	0	0	0	0	0
Agrostis capillaris subsp. *repens* (Schur) Soják	0	0	0	0	0	0	0	0
Agrostis gigantea Roth	20970	21	28	395	24	92	7	11
Agrostis gigantea Roth subsp. *gigantea*	209	9	9	0	0	0	0	0
Agrostis gigantea subsp. *glaucescens* (Widén) Valdés & H. Scholz	13	3	2	0	0	0	0	0
Agrostis gigantea subsp. *maeotica* (Klokov) Tzvelev	0	0	0	0	0	0	0	0
Agrostis gigantea subsp. *moldavica* (Dobrescu & Beldie) Dihoru	0	0	0	0	0	0	0	0
Agrostis gigantea subsp. *pontica* (Grecescu) Dihoru	0	0	0	0	0	0	0	0
Agrostis stolonifera L.	83935	26	33	120	23	67	11	13
Agrostis stolonifera subsp. *albida* (Trin.) Tzvelev	0	0	0	0	0	0	0	0
Agrostis stolonifera subsp. *filfiolia* (Link) H. Scholz	0	0	0	0	0	0	0	0

Scientific name	Population occurrences with coordinates	No. of CWR-Eco	No. of countries	Total No. seed accessions	No. of countries	No. seed accessions with coordinates	No. of CWR-Eco units	No. of countries
Agrostis stolonifera subsp. *gaditana* (Boiss. & Reut.) Valdés & H. Scholz	0	0	0	0	0	0	0	0
Agrostis stolonifera subsp. *maritima* (Lam.) Vasc.	3	1	2	0	0	0	0	0
Agrostis stolonifera subsp. *scabriglumis* (Boiss. & Reut.) Maire	4	2	1	0	0	0	0	0
Agrostis stolonifera L. subsp. *stolonifera*	141	10	5	0	0	0	0	0
Agrostis stolonifera subsp. *straminea* (Hartm.) Tzvelev	24	3	2	0	0	0	0	0
Allium albiflorum Omelczuk	1	1	1	0	0	0	0	0
Allium ampeloprasum L.	1689	23	24	151	18	53	5	6
Allium atroviolaceum Boiss.	123	6	5	15	6	7	3	1
Allium bourgeaui Rech. f.	8	2	1	0	0	0	0	0
Allium bourgeaui Rech. f. subsp. *bourgeaui*	8	2	2	0	0	0	0	0
Allium bourgeaui subsp. *creticum* Bothmer	12	2	1	0	0	0	0	0
Allium bourgeaui subsp. *cycladicum* Bothmer	37	3	1	0	0	0	0	0
Allium commutatum Guss.	39	3	5	9	4	0	0	0
Allium convallarioides Grossh.	0	0	0	0	0	0	0	0
Allium corsicum Jauzein & al.	2	1	1	0	0	0	0	0
Allium exaltatum (Meikle) Brullo, Pavone, Salmeri & Venora	0	0	0	0	0	0	0	0
Allium fistulosum L.	82	9	9	26	10	4	3	3
Allium lojaconoi Brullo, Lanfr. & Pavone	0	0	0	0	0	0	0	0
Allium melananthum Coincy	33	3	1	1	1	0	0	0
Allium pardoi Loscos	12	2	1	0	0	0	0	0
Allium pervestitum Klokov	0	0	0	0	0	0	0	0

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Allium pyrenaicum Costa & Vayr.	10	1	1	3	2	0	0	0
Allium sativum L.	588	22	24	140	15	9	4	3
Allium scabriscapum Boiss.	0	0	0	0	0	0	0	0
Allium schmitzii Cout.	13	3	2	0	0	0	0	0
Allium schoenoprasum L.	4845	20	26	153	21	36	6	6
Allium schoenoprasum subsp. *gredense* (Rivas Goday) Rivas Mart., Fern. Gonz. & Sánchez Mata	2	2	1	0	0	0	0	0
Allium schoenoprasum subsp. *latiorifolium* (Pau) Rivas Mart., Fern. Gonz. & Sánchez Mata	0	0	0	0	0	0	0	0
Allium schoenoprasum L. subsp. *schoenoprasum*	241	12	8	0	0	0	0	0
Allium truncatum (Feinbrun) F. Kollmann & D. Zohary	0	0	0	0	0	0	0	0
Allium tuberosum Rottler ex Spreng.	22	6	6	4	3	0	0	0
Alopecurus pratensis L.	56380	22	30	450	22	195	11	14
Alopecurus pratensis subsp. *alpestris* (Wahlenb.) Selander	60	3	3	0	0	0	0	0
Alopecurus pratensis subsp. *laguriformis* (Schur) Tzvelev	1	1	1	0	0	0	0	0
Alopecurus pratensis L. subsp. *pratensis*	4010	14	9	0	0	0	0	0
Alopecurus pratensis subsp. *pseudonigricans* O. Schwarz	2	2	2	0	0	0	0	0
Amblyopyrum muticum (Boiss.) Eig	11	2	1	58	3	20	2	1
Armoracia rusticana P. Gaertn. , B. Mey. & Scherb.	8952	16	26	16	4	9	4	1
Arrhenatherum elatius (L.) J. Presl & C. Presl	61690	24	32	317	28	109	9	11
Arrhenatherum elatius subsp. *baeticum* Romero Zarco	107	5	3	0	0	0	0	0

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Arrhenatherum elatius subsp. *bulbosum* (Willd.) Schübl. & G. Martens	1629	23	11	0	0	0	0	0
Arrhenatherum elatius (L.) J. Presl & C. Presl subsp. *elatius*	9168	21	13	0	0	0	0	0
Arrhenatherum elatius subsp. *nebrodense* (Brullo & al.) Giardina & Raimondo	1	1	1	0	0	0	0	0
Arrhenatherum elatius subsp. *sardoum* (Em. Schmid) Gamisans	285	9	3	0	0	0	0	0
Asparagus acutifolius L.	7263	12	12	28	3	22	4	3
Asparagus albus L.	991	7	5	3	1	0	0	0
Asparagus aphyllus L.	519	5	4	2	1	0	0	0
Asparagus aphyllus L. subsp. *aphyllus*	1	1	1	0	0	0	0	0
Asparagus aphyllus subsp. *orientalis* (Baker) P. H. Davis	7	1	2	0	0	0	0	0
Asparagus arborescens Willd. ex Schult. & Schult. f.	1	1	1	1	1	0	0	0
Asparagus densiflorus (Kunth) Jessop	22	6	3	0	0	0	0	0
Asparagus fallax Svent.	5	2	1	0	0	0	0	0
Asparagus horridus L.	712	7	6	3	3	0	0	0
Asparagus inderiensis Blume ex Ledeb.	0	0	0	0	0	0	0	0
Asparagus maritimus (L.) Mill.	15	5	3	16	2	1	1	1
Asparagus nesiotes Svent.	0	0	0	0	0	0	0	0
Asparagus nesiotes Svent. subsp. *nesiotes*	0	0	0	0	0	0	0	0
Asparagus nesiotes subsp. *purpureiensis* Marrero Rodr. & A. Ramos	2	2	1	0	0	0	0	0
Asparagus officinalis L.	7718	20	25	65	14	19	7	7

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Asparagus officinalis L. subsp. *officinalis*	8	4	2	0	0	0	0	0
Asparagus officinalis subsp. *prostratus* (Dumort.) Corb.	108	4	4	10	2	0	0	0
Asparagus pastorianus Webb & Berthel.	3	2	1	1	1	1	1	1
Asparagus plocamoides Webb ex Svent.	4	1	1	0	0	0	0	0
Asparagus pseudoscaber Grecescu	6	2	1	1	1	0	0	0
Asparagus tenuifolius Lam.	213	10	6	5	2	0	0	0
Asparagus verticillatus L.	24	6	6	1	1	0	0	0
Astartoseris triquetra (Labill.) N. Kilian & al.	0	0	0	0	0	0	0	0
Astragalus arenarius L.	60	2	8	1	1	0	0	0
Astragalus cicer L.	2969	18	26	107	19	23	6	7
Astragalus pelecinus (L.) Barneby	49	5	2	0	0	0	0	0
Astragalus pelecinus (L.) Barneby subsp. *pelecinus*	1218	8	6	619	6	492	6	6
Atriplex halimus L.	816	9	8	45	2	35	2	1
Avena barbata Link	5880	22	15	521	17	393	13	12
Avena barbata Link subsp. *barbata*	597	10	6	0	0	0	0	0
Avena barbata subsp. *castellana* Romero Zarco	4	3	2	0	0	0	0	0
Avena barbata subsp. *hirtula* (Lag.) Tab. Morais	3	2	1	17	4	6	3	2
Avena barbata subsp. *lusitanica* (Tab. Morais) Romero Zarco	78	4	3	0	0	0	0	0
Avena barbata subsp. *wiestii* (Steud.) Mansf.	1	1	1	4	3	0	0	0
Avena byzantina K. Koch	124	10	7	1	1	0	0	0
Avena clauda Durieu	8	2	3	4	2	0	0	0
Avena eriantha Durieu	10	3	3	17	4	9	4	3
Avena fatua L.	11848	27	31	304	25	164	13	14

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Avena fatua subsp. *aemulans* (Nevski) H. Scholz	0	0	0	0	0	0	0	0
Avena fatua subsp. *cultiformis* Malzev	0	0	0	0	0	0	0	0
Avena fatua L. subsp. *fatua*	291	5	2	0	0	0	0	0
Avena fatua subsp. *meridionalis* Malzev	53	7	2	0	0	0	0	0
Avena hybrida Peterm.	61	3	2	3	3	0	0	0
Avena insularis Ladiz.	0	0	0	1	1	0	0	0
Avena longiglumis Durieu	19	3	2	4	2	4	1	2
Avena murphyi Ladiz.	15	1	1	5	1	4	1	1
Avena sterilis L.	1860	21	17	1354	18	824	12	10
Avena sterilis subsp. *atherantha* (C. Presl) H. Scholz	8	3	1	0	0	0	0	0
Avena sterilis subsp. *ludoviciana* (Durieu) Gillet & Magne	528	13	11	0	0	0	0	0
Avena sterilis L. subsp. *sterilis*	417	10	8	0	0	0	0	0
Avena sterilis subsp. *trichophylla* (K. Koch) Malzev	5	2	2	0	0	0	0	0
Avena strigosa Schreb.	282	17	15	8	6	3	3	3
Barbarea verna (Mill.) Asch.	1610	20	12	2	1	0	0	0
Beta corolliflora Buttler	28	7	2	53	4	44	6	1
Beta lomatogona Fisch. & C. A. Mey.	83	6	1	56	1	49	5	1
Beta macrocarpa Guss.	61	8	5	67	8	14	6	3
Beta macrorhiza Steven	21	4	3	11	2	6	2	2
Beta nana Boiss. & Heldr.	25	4	1	58	2	29	4	1
Beta patula Aiton	1	1	1	153	2	0	0	0
Beta trigyna Waldst. & Kit.	33	7	6	26	5	8	2	2
Beta vulgaris L.	2652	22	25	943	18	345	13	15

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Beta vulgaris subsp. *adanensis* Pamuk.	10	2	1	0	0	0	0	0
Beta vulgaris subsp. *maritima* (L.) Arcang.	1120	20	17	249	6	1	1	1
Beta vulgaris L. subsp. *vulgaris*	857	14	18	0	0	0	0	0
Brassica barrelieri (L.) Janka	789	7	3	27	3	6	3	2
Brassica cretica Lam.	25	3	3	107	2	13	2	2
Brassica cretica subsp. *aegaea* (Heldr. & Halácsy) Snogerup, M. A. Gust. & Bothmer	41	2	1	0	0	0	0	0
Brassica cretica Lam. subsp. *cretica*	23	2	1	0	0	0	0	0
Brassica cretica subsp. *laconica* M. A. Gust. & Snogerup	9	3	1	0	0	0	0	0
Brassica cretica subsp. *nivea* (Boiss. & Spruner) M. A. Gust. & Snogerup	9	2	1	0	0	0	0	0
Brassica elongata Ehrh.	29	7	8	6	2	0	0	0
Brassica elongata Ehrh. subsp. *elongata*	1	1	1	0	0	0	0	0
Brassica elongata subsp. *integrifolia* (Boiss.) Breistr.	39	5	6	0	0	0	0	0
Brassica elongata subsp. *pinnatifida* (Schmalh.) Greuter & Burdet	0	0	0	0	0	0	0	0
Brassica fruticulosa Cirillo	49	7	4	37	4	9	4	2
Brassica fruticulosa subsp. *cossoniana* (Boiss. & Reut.) Maire	72	4	1	0	0	0	0	0
Brassica fruticulosa Cirillo subsp. *fruticulosa*	174	4	3	0	0	0	0	0
Brassica hilarionis Post	0	0	0	4	1	0	0	0
Brassica incana Ten.	18	4	1	63	3	12	2	1
Brassica insularis Moris	62	3	3	36	2	10	2	2
Brassica macrocarpa Guss.	3	0	1	26	1	6	0	1

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Brassica maurorum Durieu	7	3	1	0	0	0	0	0
Brassica montana Pourr.	92	5	3	8	2	1	1	1
Brassica napus L.	13217	22	28	34	12	8	6	6
Brassica nigra (L.) W. D. J. Koch	4388	21	20	50	13	14	6	7
Brassica oleracea L.	1726	24	25	199	9	48	6	7
Brassica oleracea subsp. *botrytis* (L.) Duchesne	32	9	7	0	0	0	0	0
Brassica oleracea subsp. *capitata* (L.) Duchesne	134	14	19	0	0	0	0	0
Brassica oleracea subsp. *caulorapa* (DC.) Metzg.	5	3	2	2	1	0	0	0
Brassica oleracea subsp. *fruticosa* Metzg.	155	15	9	3	2	3	2	2
Brassica oleracea L. subsp. *oleracea*	51	6	6	1	1	0	0	0
Brassica oxyrrhina (Coss.) Willk.	20	3	2	12	2	2	2	1
Brassica rapa (L.) L.	5135	24	24	153	13	14	6	8
Brassica rapa subsp. *campestris* (L.) A. R. Clapham	179	8	7	0	0	0	0	0
Brassica rapa subsp. *chinensis* (L.) Hanelt	2295	13	12	0	0	0	0	0
Brassica rapa subsp. *oleifera* (DC.) Metzg.	1525	10	10	0	0	0	0	0
Brassica rapa subsp. *pekinensis* (Lour.) Hanelt	2	2	2	0	0	0	0	0
Brassica rapa L. subsp. *rapa*	287	14	18	0	0	0	0	0
Brassica repanda subsp. *glabrescens* (Poldini) Gómez Campo	0	0	0	0	0	0	0	0
Brassica rupestris Raf.	14	2	1	25	1	14	2	1
Brassica tournefortii Gouan	86	9	8	19	8	9	4	3
Brassica villosa Biv.	15	3	1	46	1	18	3	1
Brassica villosa subsp. *drepanensis* (Caruel) Raimondo & P. Mazzola	2	1	1	5	1	2	1	1
Carthamus boissieri Halácsy	0	0	0	0	0	0	0	0

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Carthamus creticus L.	132	5	3	3	1	1	1	1
Carthamus dentatus (Forssk.) Vahl	12	4	2	0	0	0	0	0
Carthamus dentatus (Forssk.) Vahl subsp. *dentatus*	6	3	2	0	0	0	0	0
Carthamus dentatus subsp. *ruber* (Link) Hanelt	11	2	1	0	0	0	0	0
Carthamus glaucus M. Bieb.	3	1	2	1	1	1	1	1
Carthamus glaucus M. Bieb. subsp. *glaucus*	0	0	0	0	0	0	0	0
Carthamus lanatus L.	3930	13	18	21	8	9	4	4
Carthamus leucocaulos Sm.	12	2	1	0	0	0	0	0
Carthamus persicus Willd.	0	0	0	0	0	0	0	0
Carthamus tenuis (Boiss. & C. I. Blanche) Bornm.	1	1	1	1	1	0	0	0
Carthamus tenuis subsp. *foliosus* Hanelt	0	0	0	0	0	0	0	0
Carthamus tenuis subsp. *gracillimus* (Rech. f.) Hanelt	1	1	1	0	0	0	0	0
Carthamus tenuis (Boiss. & C. I. Blanche) Bornm. subsp. *tenuis*	0	0	0	0	0	0	0	0
Castanea crenata Siebold & Zucc.	8	3	4	0	0	0	0	0
Castanea sativa Mill.	18085	26	27	382	5	217	5	4
Chenopodium berlandieri Moq.	58	7	9	0	0	0	0	0
Chenopodium ficifolium Sm.	5655	12	13	4	2	0	0	0
Chenopodium hircinum Schrad.	11	6	6	0	0	0	0	0
Chenopodium quinoa Willd.	77	7	8	2	2	0	0	0
Cicer bijugum Rech. f.	12	3	1	143	1	92	4	1
Cicer canariense A. Santos & G. P. Lewis	2	2	1	5	1	0	0	0
Cicer echinospermum P. H. Davis	26	4	1	126	1	33	4	1
Cicer graecum Boiss.	5	1	1	0	0	0	0	0

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Cicer pinnatifidum Jaub. & Spach	21	7	2	102	1	65	4	1
Cicer reticulatum Ladiz.	16	3	1	411	1	113	3	1
Cichorium calvum Asch.	0	0	0	0	0	0	0	0
Cichorium endivia L.	112	13	9	2	1	0	0	0
Cichorium intybus L.	20911	26	32	276	25	152	12	15
Cichorium pumilum Jacq.	110	9	8	1	1	0	0	0
Cichorium spinosum L.	19	6	3	0	0	0	0	0
Citrullus colocynthis (L.) Schrad.	50	9	6	3	2	0	0	0
Citrullus lanatus (Thunb.) Matsum. & Nakai	455	21	24	8	2	4	3	1
Coincya monensis (L.) Greuter & Burdet	171	13	9	20	4	3	1	2
Coincya monensis subsp. *cheiranthos* (Vill.) Aedo, Leadley & Muñoz Garm	57	8	6	8	4	2	1	2
Coincya monensis (L.) Greuter & Burdet subsp. *monensis*	33	6	3	0	0	0	0	0
Coincya monensis subsp. *nevadensis* (Willk.) Leadlay	18	3	1	0	0	0	0	0
Coincya monensis subsp. *orophila* (Franco) Aedo, Leadlay & Muñoz Garm.	4	3	1	24	2	5	3	1
Coincya monensis subsp. *puberula* (Pau) Leadlay	16	3	2	0	0	0	0	0
Comarum palustre L.	54468	17	22	13	6	2	2	2
Corylus avellana L.	73387	23	32	187	17	19	6	7
Corylus colurna L.	162	8	12	4	3	2	2	2
Corylus maxima Mill.	124	6	11	0	0	0	0	0
Crambe arborea H. Christ	1	1	1	1	1	1	1	1
Crambe aspera M. Bieb.	1	1	1	0	0	0	0	0

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Crambe feuillei A. Santos ex Prina & Mart.-Laborde	0	0	0	0	0	0	0	0
Crambe filiformis Jacq.	239	7	2	11	1	4	2	1
Crambe fruticosa L. f.	4	3	1	2	1	0	0	0
Crambe gomeraea H. Christ	6	1	1	0	0	0	0	0
Crambe hispanica L.	101	10	8	11	1	0	0	0
Crambe laevigata DC. ex H. Christ	2	1	1	4	1	0	0	0
Crambe microcarpa A. Santos	0	0	0	2	1	0	0	0
Crambe pritzelii Bolle	0	0	0	2	1	0	0	0
Crambe scaberrima Bramwell	0	0	0	3	1	2	1	1
Crambe scoparia Svent.	2	2	1	0	0	0	0	0
Crambe sventenii B. Pett. ex Bramwell & Sundell	0	0	0	1	1	0	0	0
Crambe tamadabensis A. Prina & A. Marrero	1	1	1	0	0	0	0	0
Crambe wildpretii Prina & Bramwell	1	1	1	0	0	0	0	0
Cucumis dipsaceus Spach	2	2	2	1	1	0	0	0
Cucumis sativus L.	589	18	23	0	0	0	0	0
Cynara algarbiensis Mariz	91	3	2	0	0	0	0	0
Cynara auranitica Post	0	0	0	0	0	0	0	0
Cynara baetica (Spreng.) Pau	19	3	1	0	0	0	0	0
Cynara baetica (Spreng.) Pau subsp. *baetica*	14	2	1	0	0	0	0	0
Cynara cardunculus subsp. *flavescens* Wiklund	7	4	4	0	0	0	0	0
Cynara cardunculus subsp. *zingaroensis* (Raimondo & Domina) Raimondo & Domina	0	0	0	0	0	0	0	0
Cynara humilis L.	705	4	3	5	2	2	1	1
Cynara tournefortii Boiss. & Reut.	9	3	2	2	1	1	1	1
Cynodon dactylon (L.) Pers.	7348	24	25	38	10	10	3	6

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Dactylis glomerata L.	104521	30	37	11907	37	7223	25	32
Dactylis glomerata L. subsp. *glomerata*	12812	23	19	0	0	0	0	0
Dactylis glomerata subsp. *hackelii* (Asch. & Graebn.) Cif. & Giacom.	13	4	4	39	3	15	3	2
Dactylis glomerata subsp. *hispanica* (Roth) Nyman	5824	14	12	0	0	0	0	0
Dactylis glomerata subsp. *ibizensis* Stebbins & D. Zohary	0	0	0	0	0	0	0	0
Dactylis glomerata subsp. *izcoi* S. Ortíz & Rodr. Oubiña	15	3	2	0	0	0	0	0
Dactylis glomerata subsp. *juncinella* (Bory) K. Richt.	25	3	1	0	0	0	0	0
Dactylis glomerata subsp. *lobata* (Drejer) H. Lindb.	2258	10	19	26	7	12	5	7
Dactylis glomerata subsp. *lusitanica* Stebbins & D. Zohary	95	4	2	0	0	0	0	0
Dactylis glomerata subsp. *merinoana* (Horjales & al.) H. Scholz	10	4	1	0	0	0	0	0
Dactylis glomerata subsp. *oceanica* G. Guignard	1	1	1	0	0	0	0	0
Dactylis glomerata subsp. *reichenbachii* (Dalla Torre & Sarnth.) Stebbins & D. Zohary	1	1	1	0	0	0	0	0
Dactylis glomerata subsp. *rigida* (Boiss. & Heldr.) Hayek	1	1	1	0	0	0	0	0
Dactylis glomerata subsp. *slovenica* (Domin) Domin	3	3	2	0	0	0	0	0
Dactylis glomerata subsp. *stebbinsii* (Horjales & al.) H. Scholz	0	0	0	0	0	0	0	0
Daucus carota L.	36589	28	38	998	33	449	17	24

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Daucus carota subsp. *azoricus* Franco	1132	9	5	43	5	26	5	4
Daucus carota subsp. *cantabricus* A. Pujadas	4	3	1	0	0	0	0	0
Daucus carota L. subsp. *carota*	10985	25	22	61	3	14	2	2
Daucus carota subsp. *commutatus* (Paol.) Thell.	24	4	5	0	0	0	0	0
Daucus carota subsp. *drepanensis* (Lojac.) Heywood	13	2	3	0	0	0	0	0
Daucus carota subsp. *gadecaei* (Rouy & E. G. Camus) Heywood	1	1	1	0	0	0	0	0
Daucus carota subsp. *gummifer* (Syme) Hook. f.	47	7	4	0	0	0	0	0
Daucus carota subsp. *halophilus* (Brot.) A. Pujadas	5	2	1	0	0	0	0	0
Daucus carota subsp. *hispanicus* (Gouan) Thell.	44	4	3	0	0	0	0	0
Daucus carota subsp. *hispidus* (Ball) Heywood	0	0	0	2	2	1	1	1
Daucus carota subsp. *major* (Vis.) Arcang.	10	5	2	0	0	0	0	0
Daucus carota subsp. *majoricus* A. Pujadas	2	1	1	0	0	0	0	0
Daucus carota subsp. *maximus* (Desf.) Ball	240	9	6	0	0	0	0	0
Daucus carota subsp. *rupestris* (Guss.) Heywood	0	0	0	0	0	0	0	0
Daucus carota subsp. sativus (Hoffm.) Arcang.	213	14	17	0	0	0	0	0
Daucus gracilis Steinh.	0	0	0	0	0	0	0	0
Daucus sahariensis Murb.	0	0	0	0	0	0	0	0
Diplotaxis erucoides (L.) DC.	4544	12	9	13	2	8	2	2
Diplotaxis erucoides (L.) DC. subsp. *erucoides*	88	6	3	0	0	0	0	0
Diplotaxis muralis (L.) DC.	2518	20	22	11	8	2	2	2
Diplotaxis siettiana Maire	1	1	1	1	1	0	0	0
Diplotaxis siifolia Kunze	27	4	1	8	2	3	1	1
Diplotaxis siifolia Kunze subsp. *siifolia*	1	1	1	0	0	0	0	0

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Diplotaxis siifolia subsp. *vicentina* (Samp.) Mart.-Laborde	4	1	2	0	0	0	0	0
Diplotaxis tenuifolia (L.) DC.	3969	19	27	37	9	8	4	3
Echinochloa crus-galli (L.) P. Beauv.	20625	28	28	36	15	13	4	7
Echinochloa crus-galli (L.) P. Beauv. subsp. *crus-galli*	1083	11	8	0	0	0	0	0
Echinochloa crus-galli subsp. *hispidula* (Retz.) Honda	23	4	1	0	0	0	0	0
Echinochloa crus-galli subsp. *spiralis* (Vasinger) Tzvelev	46	6	2	0	0	0	0	0
Echinochloa oryzicola (Vasinger) Vasinger	18	2	1	0	0	0	0	0
Eleusine coracana (L.) Gaertn.	4	3	3	12	4	0	0	0
Eleusine tristachya (Lam.) Lam.	376	13	6	5	4	0	0	0
Elymus dahuricus Turcz. ex Griseb.	20	0	1	79	3	2	0	1
Elymus trachycaulus (Link) Shinners	3	2	1	40	6	1	0	1
Elymus trachycaulus subsp. *novae-angliae* (Scribn.) Tzvelev	0	0	0	0	0	0	0	0
Elymus trachycaulus subsp. *stefanssonii* (Melderis) Á. Löve & D. Löve	0	0	0	0	0	0	0	0
Elymus trachycaulus (Link) Shinners subsp. *trachycaulus*	0	0	0	0	0	0	0	0
Elytrigia bessarabica (Savul. & Rayss) Prokudin	1	1	1	0	0	0	0	0
Elytrigia curvifolia (Lange) Holub	1	1	1	1	1	1	1	1
Elytrigia elongata (Host) Nevski	69	9	10	25	6	3	2	2
Elytrigia elongata (Host) Nevski subsp. *elongata*	9	2	2	0	0	0	0	0

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Elytrigia elongata subsp. *haifensis* (Rech. f.) Valdés & H. Scholz	0	0	0	0	0	0	0	0
Elytrigia elongata subsp. *salsa* (Melderis) Valdés & H. Scholz	0	0	0	0	0	0	0	0
Elytrigia elongata subsp. *turcica* (McGuire) Valdés & H. Scholz	0	0	0	0	0	0	0	0
Elytrigia intermedia (Host) Nevski	2	2	2	50	9	5	2	4
Elytrigia intermedia (Host) Nevski subsp. *intermedia*	251	10	4	0	0	0	0	0
Elytrigia intermedia subsp. *mucronata* (Bercht.) Valdés & H. Scholz	1	1	1	0	0	0	0	0
Elytrigia intermedia subsp. *podperae* (Nábělek) Á. Löve	0	0	0	0	0	0	0	0
Elytrigia intermedia subsp. *pouzolzii* (Godr.) Á. Löve	0	0	0	0	0	0	0	0
Elytrigia intermedia subsp. *pulcherrima* (Grossh.) Tzvelev	0	0	0	0	0	0	0	0
Elytrigia intermedia subsp. *trichophora* (Link) Á. Löve & D. Löve	0	0	0	0	0	0	0	0
Elytrigia intermedia subsp. *varnensis* (Velen.) Valdés & H. Scholz	0	0	0	0	0	0	0	0
Elytrigia juncea (L.) Nevski	2	2	1	11	2	5	2	1
Elytrigia juncea subsp. *boreoatlantica* (Simonet & Guin.) Hyl.	1	0	1	0	0	0	0	0
Elytrigia obtusiflora (DC.) Tzvelev	3	3	3	4	4	4	4	4
Elytrigia scirpea (C. Presl) Holub	5	2	1	0	0	0	0	0
Eragrostis pilosa (L.) P. Beauv.	1611	15	16	1	1	0	0	0

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Eragrostis tef (Zuccagni) Trotter	50	9	7	1	1	0	0	0
Eruca vesicaria (L.) Cav.	1438	21	21	128	11	73	4	2
Erucastrum canariense Webb & Berthel.	3	2	1	1	1	0	0	0
Erucastrum gallicum (Willd.) O. E. Schulz	948	18	19	1	1	0	0	0
Festuca heterophylla Lam.	5202	18	22	16	7	7	4	5
Festuca ovina L.	57795	22	30	310	26	162	15	19
Festuca ovina subsp. *firmulacea* (Markgr.-Dann.) Prob.	0	0	0	0	0	0	0	0
Festuca ovina subsp. *guestfalica* (Rchb.) K. Richt.	158	7	4	0	0	0	0	0
Festuca ovina subsp. *hirtula* (Travis) M. J. Wilk.	121	6	4	0	0	0	0	0
Festuca ovina subsp. *molinieri* (Litard.) Foggi & J. Müll.	26	6	1	0	0	0	0	0
Festuca ovina subsp. *ophioliticola* (Kerguélen) M. Wilk.	37	4	2	0	0	0	0	0
Festuca ovina L. subsp. *ovina*	59	7	8	0	0	0	0	0
Festuca ovina subsp. *ruprechtii* (Boiss.) Tzvelev	0	0	0	0	0	0	0	0
Festuca ovina subsp. *supina* (Schur) Oborný	5	4	3	0	0	0	0	0
Festuca rubra L.	105478	22	36	1524	34	878	17	27
Festuca rubra subsp. *juncea* (Hack.) K. Richt.	67	14	10	0	0	0	0	0
Festuca rubra subsp. *litoralis* (G. Mey.) Auquier	6	4	1	0	0	0	0	0
Festuca rubra subsp. *pruinosa* (Hack.) Piper	63	5	4	0	0	0	0	0
Festuca rubra L. subsp. *rubra*	10709	21	16	0	0	0	0	0
Festuca rubra subsp. *scotica* Al-Bermani	2	2	1	0	0	0	0	0
Festuca rubra subsp. *thessalica* Markgr.-Dann.	1	1	1	0	0	0	0	0
Ficus carica L.	3310	6	6	19	2	7	1	1

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Ficus carica subsp. *rupestris* (Boiss.) Browicz	1	1	1	0	0	0	0	0
Fragaria chiloensis (L.) Weston	77	4	3	1	1	0	0	0
Fragaria moschata Weston	778	12	18	49	7	4	1	1
Fragaria vesca L.	69420	26	35	139	18	25	8	12
Fragaria virginiana Mill.	537	5	4	0	0	0	0	0
Fragaria viridis Weston	564	9	18	29	5	9	3	2
Fragaria viridis subsp. *campestris* (Steven) Pawł.	11	2	2	0	0	0	0	0
Fragaria viridis Weston subsp. *viridis*	5548	14	17	0	0	0	0	0
Galega orientalis Lam.	385	9	8	116	7	24	5	2
Hedysarum coronarium L.	224	8	10	154	8	54	4	3
Helianthus annuus L.	5686	21	24	18	6	0	0	0
Helianthus debilis Nutt.	16	7	5	0	0	0	0	0
Helianthus decapetalus L.	12	7	7	1	1	0	0	0
Helianthus giganteus L.	5	2	3	1	1	0	0	0
Helianthus pauciflorus Nutt.	281	6	14	0	0	0	0	0
Helianthus petiolaris Nutt.	54	4	6	3	3	0	0	0
Helianthus strumosus L.	6	3	2	1	1	0	0	0
Hordeum brevisubulatum (Trin.) Link	41	1	2	15	3	1	1	1
Hordeum brevisubulatum (Trin.) Link subsp. *brevisubulatum*	0	0	0	0	0	0	0	0
Hordeum brevisubulatum subsp. *nevskianum* (Bowden) Tzvelev	0	0	0	0	0	0	0	0
Hordeum brevisubulatum subsp. *turkestanicum* (Nevski) Tzvelev	0	0	0	0	0	0	0	0

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Hordeum brevisubulatum subsp. *violaceum* (Boiss. & Hohen.) Tzvelev	8	4	2	0	0	0	0	0
Hordeum bulbosum L.	471	11	10	305	15	154	11	9
Hordeum bulbosum L. subsp. *bulbosum*	1	1	1	0	0	0	0	0
Hordeum bulbosum subsp. *nodosum* (L.) B. R. Baum	0	0	0	0	0	0	0	0
Hordeum jubatum L.	900	13	17	7	6	2	1	2
Hordeum marinum Huds.	831	18	19	203	17	97	11	10
Hordeum vulgare L.	3420	27	29	271	10	151	9	6
Hordeum vulgare subsp. *aegiceras* (Nees ex Royle) Á. Löve	0	0	0	0	0	0	0	0
Hordeum vulgare subsp. *agriocrithon* (Åberg) Á. Löve & D. Löve	2	2	2	0	0	0	0	0
Hordeum vulgare subsp. *distichon* (L.) Körn.	1165	12	8	1	1	0	0	0
Hordeum vulgare subsp. *spontaneum* (K. Koch) Thell.	37	6	3	104	2	0	0	0
Humulus lupulus L.	30928	23	31	406	21	21	4	5
Juglans ailantifolia Carrière	5	1	2	0	0	0	0	0
Juglans cinerea L.	27	6	9	0	0	0	0	0
Juglans mandshurica Maxim.	32	5	6	2	1	0	0	0
Juglans nigra L.	381	12	14	0	0	0	0	0
Juglans regia L.	14984	25	30	470	11	252	7	2
Lactuca aculeata Boiss. & Kotschy	2	1	1	1	1	1	1	1
Lactuca alpestris (Gand.) Rech. f.	4	1	1	0	0	0	0	0
Lactuca cyprica (Rech. f.) N. Kilian & Greuter	1	1	1	0	0	0	0	0
Lactuca georgica Grossh.	10	0	1	9	1	7	0	1

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Lactuca saligna L.	862	15	16	104	12	28	8	9
Lactuca scarioloides Boiss.	0	0	0	0	0	0	0	0
Lactuca serriola L.	27340	28	33	1263	29	804	18	24
Lactuca singularis Wilmott	9	3	1	0	0	0	0	0
Lactuca tetrantha B. L. Burtt & P. H. Davis	0	0	0	0	0	0	0	0
Lactuca virosa L.	4399	21	14	181	12	101	6	8
Lactuca virosa subsp. *livida* (Boiss. & Reut.) Ladero & A. Velasco	2	2	1	0	0	0	0	0
Lactuca watsoniana Trel.	369	6	1	0	0	0	0	0
Lathyrus amphicarpos L.	39	3	4	8	2	6	2	1
Lathyrus annuus L.	751	15	14	179	10	122	9	7
Lathyrus blepharicarpus Boiss.	13	7	2	26	3	20	7	3
Lathyrus cassius Boiss.	5	3	2	11	2	9	3	2
Lathyrus chloranthus Boiss.	3	2	1	1	1	1	1	1
Lathyrus cicera L.	95	12	6	483	17	189	11	5
Lathyrus cirrhosus Ser.	56	6	2	22	2	21	2	1
Lathyrus clymenum L.	1230	20	10	176	13	81	7	6
Lathyrus gorgoni Parl.	42	7	5	103	3	72	6	2
Lathyrus grandiflorus Sibth. & Sm.	142	9	9	4	2	3	2	2
Lathyrus heterophyllus L.	241	13	9	9	2	8	2	1
Lathyrus hierosolymitanus Boiss.	54	5	3	109	4	74	5	3
Lathyrus hirsutus L.	2353	21	21	141	14	54	6	9
Lathyrus latifolius L.	6976	24	26	71	12	42	5	4
Lathyrus latifolius L. var. *latifolius*	616	12	5	0	0	0	0	0
Lathyrus ochrus (L.) DC.	361	12	8	224	12	82	7	6

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Lathyrus odoratus L.	217	14	13	12	6	3	1	1
Lathyrus rotundifolius Willd.	66	8	3	1	1	1	0	1
Lathyrus sativus L.	415	22	21	498	22	29	5	5
Lathyrus stenophyllus Boiss. & Heldr.	3	2	1	13	1	10	3	1
Lathyrus sylvestris L.	8555	23	26	120	15	53	10	8
Lathyrus tingitanus L.	465	14	5	75	8	48	7	2
Lathyrus tuberosus L.	6836	19	29	58	9	29	3	6
Lathyrus undulatus Boiss.	0	0	0	0	0	0	0	0
Lens culinaris subsp. *odemensis* (Ladiz.) M. E. Ferguson & al.	1	1	1	0	0	0	0	0
Lens culinaris subsp. *orientalis* (Boiss.) Ponert	9	5	3	6	1	6	3	1
Lens ervoides (Brign.) Grande	145	11	11	243	10	169	8	10
Lens lamottei Czefr.	29	4	3	30	3	25	4	3
Lens nigricans (M. Bieb.) Godr.	443	12	12	216	12	155	9	10
Lepidium meyeri subsp. *turczaninowii* (Lipsky) Schmalh.	0	0	0	0	0	0	0	0
Lepidium sativum L.	535	20	17	8	4	1	1	1
Lepidium sativum L. subsp. *sativum*	11	4	2	0	0	0	0	0
Leymus angustus (Trin.) Pilg.	3	0	1	21	2	6	0	1
Leymus arenarius (L.) Hochst.	5016	9	17	65	11	7	2	2
Leymus mollis (Trin.) H. Hara	24	2	3	5	1	1	0	1
Leymus racemosus (Lam.) Tzvelev	33	6	5	21	5	1	0	1
Leymus racemosus subsp. *klokovii* Tzvelev	1	0	1	0	0	0	0	0
Leymus racemosus (Lam.) Tzvelev subsp. *racemosus*	0	0	0	0	0	0	0	0

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Leymus racemosus subsp. *sabulosus* (M. Bieb.) Tzvelev	1	1	1	0	0	0	0	0
Linum bienne Mill.	2203	21	18	19	13	1	1	1
Linum corymbiferum Desf.	1	1	1	0	0	0	0	0
Linum decumbens Desf.	7	4	3	2	1	2	2	1
Linum hirsutum L.	51	5	9	10	6	3	2	2
Linum hirsutum subsp. *anatolicum* (Boiss.) Hayek	1	1	1	0	0	0	0	0
Linum hirsutum subsp. *bozdaghense* Yılmaz & Kaynak	0	0	0	0	0	0	0	0
Linum hirsutum subsp. *byzantinum* Azn.	0	0	0	0	0	0	0	0
Linum hirsutum subsp. glabrescens (Rochel) Soó	2	2	2	0	0	0	0	0
Linum hirsutum L. subsp. *hirsutum*	12	2	3	0	0	0	0	0
Linum hirsutum subsp. *oreocaricum* P. H. Davis	0	0	0	0	0	0	0	0
Linum hirsutum subsp. *platyphyllum* (P. H. Davis) Yılmaz & Kaynak	0	0	0	0	0	0	0	0
Linum hirsutum subsp. *pseudoanatolicum* P. H. Davis	0	0	0	0	0	0	0	0
Linum hirsutum subsp. *spathulatum* (Halácsy & Bald.) Hayek	0	0	0	0	0	0	0	0
Linum nervosum Waldst. & Kit.	54	6	4	2	2	0	0	0
Linum nervosum subsp. *jailicola* (Juz.) T. V. Egorova	0	0	0	0	0	0	0	0
Lolium multiflorum Lam.	19442	28	27	449	22	300	14	17
Lolium perenne L.	79054	27	35	5878	36	4116	21	31
Lolium perenne L. subsp. *perenne*	0	0	0	0	0	0	0	0
Lolium rigidum Gaudin	3322	20	17	123	12	65	10	7

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Lolium rigidum subsp. *lepturoides* Sennen & Mauricio	51	4	3	4	1	1	1	1
Lolium rigidum Gaudin subsp. *rigidum*	397	8	5	0	0	0	0	0
Lolium temulentum L.	411	20	19	133	15	64	8	10
Lotus corniculatus L.	75926	29	36	1213	34	395	20	21
Lotus corniculatus subsp. *frondosus* Freyn	3	1	1	0	0	0	0	0
Lotus pedunculatus Cav.	42974	24	24	324	13	66	12	7
Lotus subbiflorus Lag.	1190	14	10	31	8	14	5	3
Lupinus albus L.	481	19	12	867	21	42	4	4
Lupinus albus L. subsp. *albus*	18	3	3	0	0	0	0	0
Lupinus albus subsp. *graecus* (Boiss. & Spruner) Franco & P. Silva	19	4	2	3	1	0	0	0
Lupinus angustifolius L.	1548	17	20	2219	19	573	9	5
Lupinus angustifolius L. subsp. *angustifolius*	84	8	5	0	0	0	0	0
Lupinus angustifolius subsp. *reticulatus* (Desv.) Arcang.	82	4	3	3	3	0	0	0
Lupinus cosentinii Guss.	20	6	7	37	4	6	1	2
Lupinus hispanicus Boiss. & Reut.	188	7	3	400	4	50	4	1
Lupinus hispanicus var. *bicolor* (Merino) Gladst.	0	0	0	0	0	0	0	0
Lupinus luteus L.	756	15	14	1486	22	257	7	4
Lupinus micranthus Guss.	129	6	7	71	6	20	4	3
Lupinus pilosus L.	30	6	5	71	10	6	3	2
Malus crescimannoi Raimondo	1	1	1	2	1	1	1	1
Malus pumila Mill.	18526	26	24	7	4	1	1	1
Malus sylvestris (L.) Mill.	18768	22	26	90	7	19	5	2

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Malus sylvestris subsp. *orientalis* (Uglitzk.) Browicz	57	11	2	460	2	414	5	1
Malus sylvestris subsp. *praecox* (Pall.) Soó	38	4	2	0	0	0	0	0
Malus sylvestris (L.) Mill. subsp. *sylvestris*	399	10	5	0	0	0	0	0
Medicago arborea L.	113	7	5	52	6	19	4	4
Medicago cancellata M. Bieb.	9	1	1	20	1	11	1	1
Medicago constricta Durieu	76	8	5	287	9	167	8	6
Medicago cretacea M. Bieb.	16	1	2	9	2	8	2	2
Medicago doliata Carmign.	372	7	6	456	15	306	6	7
Medicago falcata L.	7849	23	30	604	24	188	10	17
Medicago fischeriana (Ser.) Trautv.	2	1	1	13	1	6	2	1
Medicago glomerata Balb.	34	4	3	25	4	4	2	3
Medicago heyniana Greuter	2	1	1	7	1	3	1	1
Medicago hypogaea E. Small	3	2	1	0	0	0	0	0
Medicago littoralis Loisel.	2347	13	7	1170	15	664	13	9
Medicago lupulina L.	50136	30	38	691	34	318	17	27
Medicago lupulina var. *cupaniana* (Guss.) Boiss.	3	3	2	0	0	0	0	0
Medicago marina L.	289	10	9	86	8	44	8	6
Medicago murex Willd.	274	11	9	906	12	633	10	7
Medicago papillosa Boiss.	3	3	1	10	1	1	1	1
Medicago pironae Vis.	1	1	1	3	2	2	1	1
Medicago polymorpha L.	5676	26	21	3360	19	2313	17	12
Medicago prostrata Jacq.	19	3	9	19	3	15	4	3
Medicago rigidula (L.) All.	2098	15	13	1766	16	1427	14	13
Medicago rugosa Desr.	137	8	6	321	11	229	8	6
Medicago rupestris M. Bieb.	0	0	0	0	0	0	0	0

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Medicago sativa L.	17844	26	35	1705	33	370	16	26
Medicago sativa subsp. *microcarpa* Urb.	2	0	1	0	0	0	0	0
Medicago sativa L. subsp. *sativa*	3052	18	10	0	0	0	0	0
Medicago sativa nothosubsp. *varia* (Martyn) Arcang.	3266	17	26	8	2	0	0	0
Medicago scutellata (L.) Mill.	172	12	10	351	15	168	10	8
Medicago soleirolii Duby	12	3	3	4	3	2	2	2
Medicago strasseri Greuter & al.	1	1	1	3	2	2	2	2
Medicago tornata subsp. *helix* (Willd.) Ooststr. & Reichg.	22	6	4	142	10	83	7	5
Medicago truncatula Gaertn.	1032	15	11	2678	17	1766	14	11
Medicago turbinata (L.) All.	104	10	7	263	14	148	8	6
Melilotus albus Medik.	21978	27	35	472	26	109	13	14
Melilotus officinalis (L.) Lam.	15114	23	32	262	20	62	9	13
Mentha suaveolens Ehrh.	10554	22	20	32	8	12	6	2
Mentha suaveolens subsp. *insularis* (Req. ex Gren. & Godr.) Greuter	65	5	3	0	0	0	0	0
Mentha suaveolens Ehrh. subsp. *suaveolens*	405	12	5	0	0	0	0	0
Moricandia arvensis (L.) DC.	1319	10	5	21	3	7	4	2
Myrtus communis L.	2943	14	12	13	4	0	0	0
Myrtus communis L. subsp. *communis*	8	2	3	0	0	0	0	0
Myrtus communis subsp. *tarentina* (L.) Nyman	3	2	2	0	0	0	0	0
Ochlopoa annua (L.) H. Scholz	20227	23	10	157	8	111	9	6
Ochlopoa annua (L.) H. Scholz subsp. *annua*	17	3	1	0	0	0	0	0

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Ochlopoa annua subsp. *notabilis* (Chrtek & V. Jirásek) H. Scholz & Valdés	0	0	0	0	0	0	0	0
Ochlopoa annua subsp. *pilantha* (Ronniger) H. Scholz & Valdés	0	0	0	0	0	0	0	0
Ochlopoa annua subsp. *raniglumis* (E. Fröhner) H. Scholz & Valdés	5	1	1	0	0	0	0	0
Olea europaea subsp. *cerasiformis* G. Kunkel & Sunding	3	3	1	0	0	0	0	0
Olea europaea L. subsp. *europaea*	844	8	7	122	6	10	3	2
Olea europaea subsp. *guanchica* P. Vargas & al.	10	2	1	0	0	0	0	0
Onobrychis viciifolia Scop.	6862	22	26	476	20	125	13	15
Ornithopus compressus L.	4068	23	13	2943	9	2255	12	7
Ornithopus sativus Brot.	514	18	13	323	10	148	4	2
Ornithopus sativus subsp. *isthmocarpus* (Coss.) Dostál	42	3	2	0	0	0	0	0
Oryza rufipogon Griff.	0	0	0	0	0	0	0	0
Panicum miliaceum subsp. *agricolum* H. Scholz & Mikoláš	24	5	2	0	0	0	0	0
Panicum miliaceum subsp. *ruderale* (Kitag.) Tzvelev	54	6	6	0	0	0	0	0
Papaver somniferum L.	6607	24	21	22	10	8	3	2
Patellifolia procumbens (C. Sm.) A. J. Scott & al.	14	3	1	23	4	0	0	0
Phalaris aquatica L.	345	13	9	206	8	77	6	6
Phalaris canariensis L.	2277	22	20	25	14	4	4	3
Phalaroides arundinacea (L.) Rauschert	69893	21	31	537	23	223	10	13

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Phalaroides arundinacea (L.) Rauschert subsp. *arundinacea*	4412	18	9	0	0	0	0	0
Phalaroides arundinacea subsp. *oehleri* (Pilg.) Valdés & H. Scholz	0	0	0	1	1	1	1	1
Phalaroides arundinacea subsp. *rotgesii* (Husn.) Valdés & H. Scholz	0	0	0	0	0	0	0	0
Phleum nodosum L.	10	6	6	92	10	32	8	7
Phleum pratense L.	48377	25	35	4751	31	3191	14	23
Phleum pratense subsp. *brachystachyum* (Salis) Gamisans	0	0	0	0	0	0	0	0
Phleum pratense L. subsp. *pratense*	24705	17	15	0	0	0	0	0
Phoenix canariensis Chabaud	107	10	7	256	2	196	4	1
Phoenix dactylifera L.	159	13	13	7	2	6	3	2
Phoenix theophrasti Greuter	3	2	1	0	0	0	0	0
Pistacia atlantica Desf.	23	7	5	5	3	0	0	0
Pistacia atlantica subsp. *cypricola* H. Lindb.	0	0	0	0	0	0	0	0
Pistacia atlantica subsp. *mutica* (Fisch. & C. A. Mey.) Rech. f.	0	0	0	0	0	0	0	0
Pistacia eurycarpa Yalt.	1	1	1	0	0	0	0	0
Pistacia khinjuk Stocks	0	0	0	0	0	0	0	0
Pistacia lentiscus L.	10886	12	12	22	7	5	2	2
Pistacia terebinthus L.	3137	14	11	23	7	11	1	2
Pistacia terebinthus subsp. *palaestina* (Boiss.) Engl.	1	1	1	0	0	0	0	0
Pistacia terebinthus L. subsp. *terebinthus*	1	1	1	0	0	0	0	0
Pisum fulvum Sm.	8	4	3	74	8	11	3	2

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Pisum sativum subsp. *elatius* (M. Bieb.) Asch. & Graebn.	194	11	10	83	7	44	6	2
Pisum sativum L. subsp. *sativum*	70	10	10	0	0	0	0	0
Plantago lanceolata L.	99812	31	34	301	22	130	11	12
Poa alpina L.	10822	19	24	84	15	33	9	9
Poa alpina L. subsp. *alpina*	595	12	10	0	0	0	0	0
Poa alpina subsp. *brevifolia* Gaudin	1	1	1	0	0	0	0	0
Poa palustris L.	17068	17	23	96	15	33	6	6
Poa palustris L. subsp. *palustris*	3	2	1	0	0	0	0	0
Poa palustris subsp. *volhynensis* (Klokov) Tzvelev	0	0	0	0	0	0	0	0
Poa pratensis L.	72951	27	32	3412	31	2136	17	24
Poa pratensis subsp. *colpodea* (Th. Fr.) Tzvelev	1	0	1	0	0	0	0	0
Poa pratensis subsp. *dolichophylla* (Hack.) Portal	0	0	0	0	0	0	0	0
Poa pratensis subsp. *irrigata* (Lindm.) H. Lindb.	1547	11	10	5	2	5	4	2
Poa pratensis subsp. *jordanii* Portal	6	2	1	0	0	0	0	0
Poa pratensis L. subsp. *pratensis*	11869	22	16	0	0	0	0	0
Poa pratensis subsp. *rigens* (Hartm.) Tzvelev	0	0	0	0	0	0	0	0
Poa pratensis subsp. *turfosa* (Litv.) Vorosch.	0	0	0	0	0	0	0	0
Poa trivialis L.	81638	27	32	57	15	27	7	8
Poa trivialis subsp. *latifolia* (Schur) Portal	0	0	0	0	0	0	0	0
Poa trivialis subsp. *semineutra* (Willd.) Portal	0	0	0	0	0	0	0	0
Poa trivialis subsp. *sylvicola* (Guss.) H. Lindb.	379	12	8	0	0	0	0	0
Poa trivialis L. subsp. *trivialis*	3347	15	15	0	0	0	0	0
Prunus arabica (Olivier) Meikle	1	1	1	0	0	0	0	0
Prunus argentea (Lam.) Rehder	0	0	0	1	1	1	1	1

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Prunus armeniaca L.	168	18	15	34	5	11	3	2
Prunus avium (L.) L.	47044	26	30	83	11	9	2	1
Prunus brigantina Vill.	73	5	1	0	0	0	0	0
Prunus carduchorum (Bornm.) Meikle	0	0	0	0	0	0	0	0
Prunus cerasifera Ehrh.	5412	18	25	43	5	27	4	2
Prunus discolor (Spach) C. K. Schneid.	0	0	0	0	0	0	0	0
Prunus dulcis (Mill.) D. A. Webb	1687	19	16	5	4	1	1	1
Prunus fenzliana R. M. Fritsch	0	0	0	0	0	0	0	0
Prunus fruticosa Pall.	55	4	11	2	2	0	0	0
Prunus incana (Pall.) Steven	3	1	1	0	0	0	0	0
Prunus kotschyi (Spach) Náb.	0	0	0	2	1	0	0	0
Prunus lusitanica L.	619	10	9	5	2	0	0	0
Prunus lusitanica subsp. *azorica* (Mouill.) Franco	0	0	0	0	0	0	0	0
Prunus lusitanica subsp. *hixa* (Willd.) Franco	0	0	0	0	0	0	0	0
Prunus lusitanica L. subsp. *lusitanica*	5	2	1	0	0	0	0	0
Prunus lycioides (Spach) C. K. Schneid.	0	0	0	0	0	0	0	0
Prunus mahaleb L.	6281	20	27	302	13	4	4	2
Prunus microcarpa C. A. Mey.	1	1	1	0	0	0	0	0
Prunus padus L.	37507	19	23	38	4	1	1	1
Prunus padus subsp. *borealis* (A. Blytt) Nyman	217	10	6	0	0	0	0	0
Prunus padus L. subsp. *padus*	9754	13	15	0	0	0	0	0
Prunus persica (L.) Batsch	527	18	17	22	4	8	1	1
Prunus prostrata Labill.	204	8	6	1	1	0	0	0
Prunus ramburii Boiss.	100	4	1	2	1	0	0	0
Prunus spinosa L.	51479	23	28	76	9	2	1	1

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Prunus spinosa subsp. *dasyphylla* (Schur) Domin	43	3	3	0	0	0	0	0
Prunus spinosa L. subsp. *spinosa*	3401	12	5	0	0	0	0	0
Prunus tomentosa Thunb.	1	1	1	0	0	0	0	0
Prunus trichamygdalus Hand.-Mazz.	0	0	0	0	0	0	0	0
Prunus webbii (Spach) Vierh.	10	3	2	0	0	0	0	0
Pyrus bourgaeana Decne.	547	5	3	1	1	0	0	0
Pyrus communis L.	8509	24	30	59	16	26	8	7
Pyrus communis subsp. *caucasica* (Fed.) Browicz	33	5	2	0	0	0	0	0
Pyrus communis L. subsp. *communis*	110	9	9	0	0	0	0	0
Pyrus communis subsp. *pyraster* (L.) Ehrh.	5873	17	23	0	0	0	0	0
Pyrus cordata Desv.	782	8	5	69	5	3	2	2
Pyrus elaeagrifolia Pall.	14	2	1	14	5	4	1	1
Pyrus elaeagrifolia subsp. *bulgarica* (Kuth. & Sachok.) Valev	1	1	1	0	0	0	0	0
Pyrus elaeagrifolia Pall. subsp. *elaeagrifolia*	0	0	0	0	0	0	0	0
Pyrus elaeagrifolia subsp. *kotschyana* (Decne.) Browicz	0	0	0	0	0	0	0	0
Pyrus magyarica Terpó	0	0	0	0	0	0	0	0
Pyrus nivalis Jacq.	27	4	6	5	2	3	1	1
Pyrus salicifolia Pall.	23	6	7	1	1	0	0	0
Pyrus spinosa Forssk.	684	9	9	42	6	29	3	3
Pyrus syriaca Boiss.	1	1	1	1	1	0	0	0
Raphanus raphanistrum L.	16867	24	26	184	20	64	11	11
Raphanus raphanistrum subsp. *landra* (Moretti ex DC.) Bonnier & Layens	570	16	12	8	3	2	2	2

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Raphanus raphanistrum L. subsp. *raphanistrum*	4344	23	13	2	2	1	1	1
Raphanus raphanistrum subsp. *rostratus* (DC.) Thell.	0	0	0	0	0	0	0	0
Raphanus sativus L.	1596	17	26	9	5	4	3	3
Ribes aureum Pursh	323	11	16	0	0	0	0	0
Ribes divaricatum Douglas	36	5	5	1	1	0	0	0
Ribes multiflorum Roem. & Schult.	1	1	1	9	2	0	0	0
Ribes multiflorum Roem. & Schult. subsp. *multiflorum*	2	1	1	0	0	0	0	0
Ribes multiflorum subsp. *sandalioticum* Arrigoni	9	1	1	0	0	0	0	0
Ribes nigrum L.	18715	17	20	59	1	0	0	0
Ribes petraeum Wulfen	477	12	9	1	1	0	0	0
Ribes rubrum L.	23935	18	21	3	2	1	1	1
Ribes sanguineum Pursh	2588	11	12	0	0	0	0	0
Ribes spicatum E. Robson	6434	11	15	17	4	0	0	0
Ribes spicatum subsp. *hispidulum* (Jancz.) Hämet-Ahti	0		0	0	0	0	0	0
Ribes spicatum subsp. *lapponicum* Hyl.	574	3	3	0	0	0	0	0
Ribes spicatum E. Robson subsp. *spicatum*	3339	5	4	0	0	0	0	0
Ribes uva-crispa L.	28073	21	25	2	1	1	1	1
Rorippa prolifera (Heuff.) Neilr.	8	2	2	1	1	0	0	0
Rorippa valdes-bermejoi (Castrov.) Mart.-Laborde & Castrov.	4	1	1	0	0	0	0	0
Rubus cockburnianus Hemsl.	59	4	3	0	0	0	0	0
Rubus idaeus L.	77885	19	31	373	13	58	6	6

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Rubus idaeus L. subsp. *idaeus*	104	9	5	0	0	0	0	0
Rubus idaeus subsp. *melanolasius* Focke	0	0	0	0	0	0	0	0
Rubus illecebrosus Focke	0	0	0	0	0	0	0	0
Rubus occidentalis L.	0	0	0	16	2	0	0	0
Rubus odoratus L.	1150	11	12	0	0	0	0	0
Rubus phoenicolasius Maxim.	206	7	9	0	0	0	0	0
Rubus saxatilis L.	42072	20	27	6	3	3	2	2
Rubus spectabilis Pursh	869	8	10	0	0	0	0	0
Saccharum spontaneum L.	1	1	1	2	2	0	0	0
Saccharum spontaneum subsp. *aegyptiacum* (Willd.) Hack.	2	1	1	0	0	0	0	0
Salsola vermiculata L.	357	6	3	15	2	9	2	1
Schedonorus arundinaceus (Schreb.) Dumort.	276	17	19	2275	30	926	18	25
Schedonorus arundinaceus (Schreb.) Dumont subsp. *arundinaceus*	2057	15	3	8	4	0	0	0
Schedonorus arundinaceus subsp. *atlantigenus* (St.-Yves) H. Scholz	0	0	0	0	0	0	0	0
Schedonorus arundinaceus subsp. *cirtensis* (St.-Yves) H. Scholz & Valdés	0	0	0	0	0	0	0	0
Schedonorus arundinaceus subsp. *corsicus* (Hack.) Foggi & Signorini	2	2	2	0	0	0	0	0
Schedonorus arundinaceus subsp. *fenas* (Lag.) H. Scholz	1	1	1	6	2	2	2	2
Schedonorus arundinaceus subsp. *mediterraneus* (Hack.) H. Scholz & Valdés	3	2	1	0	0	0	0	0

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Schedonorus arundinaceus subsp. *orientalis* (Hack.) H. Scholz & Valdés	4	1	2	5	2	5	1	2
Schedonorus giganteus (L.) Holub	5610	19	18	146	19	114	11	16
Schedonorus pratensis (Huds.) P. Beauv.	436	17	24	6107	30	4259	18	26
Schedonorus pratensis subsp. *apenninus* (De Not.) H. Scholz & Valdés	11	5	2	76	5	34	6	5
Schedonorus pratensis (Huds.) P. Beauv. subsp. *pratensis*	279	11	1	2	2	0	0	0
Secale cereale L.	3494	21	26	112	13	53	6	7
Secale cereale subsp. *ancestrale* Zhuk.	1	1	1	21	4	0	0	0
Secale cereale L. subsp. *cereale*	41	9	5	0	0	0	0	0
Secale strictum (C. Presl) C. Presl	26	6	5	114	12	56	9	8
Secale strictum subsp. *anatolicum* (Boiss.) Hammer	0	0	0	1	1	0	0	0
Secale strictum subsp. *balcanum* (Ganchev) Valdés & H. Scholz	0	0	0	0	0	0	0	0
Secale strictum subsp. *ciliatoglume* (Boiss.) Hammer	0	0	0	0	0	0	0	0
Secale strictum (C. Presl) C. Presl subsp. *strictum*	0	0	0	0	0	0	0	0
Secale sylvestre Host	48	5	6	89	9	65	2	3
Secale vavilovii Grossh.	4	2	1	20	8	3	3	2
Securigera varia (L.) Lassen	10120	21	32	139	14	38	10	11
Setaria italica (L.) P. Beauv.	729	14	18	7	6	3	2	3
Setaria italica (L.) P. Beauv. subsp. *italica*	7	1	2	0	0	0	0	0
Setaria italica subsp. *moharia* (Alef.) R. A. W.	14	4	1	0	0	0	0	0
Setaria italica subsp. *pycnocoma* (Steud.) De Wet	212	8	2	0	0	0	0	0

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Sinapidendron angustifolium (DC.) Lowe	1	1	1	2	1	0	0	0
Sinapidendron frutescens Lowe	1	1	1	2	1	0	0	0
Sinapidendron frutescens (Sol.) Lowe var. *frutescens*	0	0	0	0	0	0	0	0
Sinapidendron frutescens subsp. *succulentum* (Lowe) Rustan	0	0	0	0	0	0	0	0
Sinapidendron gymnocalyx (Lowe) Rustan	0	0	0	0	0	0	0	0
Sinapidendron rupestre Lowe	0	0	0	2	1	0	0	0
Sinapidendron sempervivifolium Menezes	0	0	0	0	0	0	0	0
Sinapis alba L.	3214	24	25	57	17	19	6	8
Sinapis alba L. subsp. *alba*	151	10	11	0	0	0	0	0
Sinapis alba subsp. *dissecta* (Lag.) Simonk.	5	3	3	0	0	0	0	0
*Sinapis alb*a subsp. *mairei* (H. Lindb.) Maire	319	8	6	0	0	0	0	0
Sinapis arvensis L.	24855	25	28	69	17	33	9	11
Sinapis arvensis L. subsp. *arvensis*	24883	25	27	0	0	0	0	0
Sinapis arvensis var. *orientalis* (L.) W. D. J. Koch & Ziz	526	5	6	0	0	0	0	0
Sinapis flexuosa Poir.	9	4	1	5	1	3	2	1
Solanum lidii Sunding	3	2	1	5	1	0	0	0
Solanum linnaeanum Hepper & P.-M. L. Jaeger	123	8	4	7	3	1	1	1
Solanum marginatum L. f.	16	3	1	1	1	0	0	0
Solanum sisymbrifolium Lam.	9	6	5	0	0	0	0	0
Solanum torvum Sw.	0	0	0	0	0	0	0	0
Sorghum bicolor (L.) Moench	313	15	21	7	4	0	0	0
Sorghum halepense (L.) Pers.	2404	25	23	6	5	2	2	2

Scientific name	Population occurrences with coordinates	No. of CWR-Eco	No. of countries	Total No. seed accessions	No. of countries	No. seed accessions with coordinates	No. of CWR-Eco units	No. of countries
Trifolium alexandrinum L.	448	17	15	135	13	20	6	6
Trifolium alpestre L.	2211	20	29	127	22	73	10	15
Trifolium alpestre L. var. *alpestre*	28	6	1	0	0	0	0	0
Trifolium alpestre var. *durmitoreum* Rohlena	0	0	0	0	0	0	0	0
Trifolium ambiguum M. Bieb.	40	8	4	165	5	54	7	3
Trifolium angustifolium L.	3900	23	19	496	15	376	13	13
Trifolium argutum Banks & Sol.	92	6	2	115	4	95	6	2
Trifolium arvense L.	22952	32	35	347	22	189	17	16
Trifolium fragiferum L.	8766	23	34	309	31	163	14	20
Trifolium fragiferum subsp. *bonannii* (C. Presl) Soják	64	5	4	0	0	0	0	0
Trifolium fragiferum L. subsp. *fragiferum*	140	8	7	0	0	0	0	0
Trifolium hirtum All.	683	16	12	481	11	369	12	10
Trifolium hybridum L.	25229	22	31	470	28	171	17	22
Trifolium hybridum subsp. *anatolicum* (Boiss.) M. Hossain	5	2	3	1	1	1	1	1
Trifolium hybridum subsp. *elegans* (Savi) Asch. & Graebn.	999	15	12	2	2	1	1	1
Trifolium hybridum L. subsp. *hybridum*	8635	21	21	4	1	0	0	0
Trifolium incarnatum L.	2391	21	24	119	16	68	8	8
Trifolium incarnatum L. subsp. *incarnatum*	148	11	9	0	0	0	0	0
Trifolium incarnatum subsp. *molinerii* (Hornem.) Syme	198	10	9	0	0	0	0	0
Trifolium isthmocarpum Brot.	40	5	4	24	4	14	4	2
Trifolium isthmocarpum Brot. subsp. *isthmocarpum*	6	3	1	0	0	0	0	0

Scientific name	Population occurrences with coordinates	No. of CWR-Eco	No. of countries	Total No. seed accessions	No. of countries	No. seed accessions with coordinates	No. of CWR-Eco units	No. of countries
Trifolium isthmocarpum subsp. *jaminianum* (Boiss.) Murb.	1	1	1	0	0	0	0	0
Trifolium michelianum Savi	149	10	9	111	8	76	5	6
Trifolium michelianum var. *balansae* (Boiss.) Azn.	1	1	1	1	1	0	0	0
Trifolium michelianum Savi var. *michelianum*	0	0	0	0	0	0	0	0
Trifolium pratense L.	101439	27	39	3391	37	1086	21	34
Trifolium pratense var. *americanum* Harz	39	5	2	0	0	0	0	0
Trifolium pratense var. *frigidum* Gaudin	1	1	1	0	0	0	0	0
Trifolium pratense var. *maritimum* Zabel	118	12	7	0	0	0	0	0
Trifolium pratense L. var. *pratense*	5489	20	17	0	0	0	0	0
Trifolium pratense var. *sativum* Schreb.	936	8	10	0	0	0	0	0
Trifolium repens L.	120364	29	34	2696	36	1411	21	31
Trifolium repens var. *biasolettii* (Steud. & Hochst.) Asch. & Graebn.	0	0	0	0	0	0	0	0
Trifolium repens var. *macrorrhizum* Boiss.	0	0	0	0	0	0	0	0
Trifolium repens var. *nevadense* (Boiss.) C. Vicioso	39	5	3	0	0	0	0	0
Trifolium repens var. *ochranthum* K. Malý	0	0	0	0	0	0	0	0
Trifolium repens var. *orbelicum* (Velen.) R. M. Fritsch	1	1	1	0	0	0	0	0
Trifolium repens var. *orphanideum* (Boiss.) Boiss.	0	0	0	0	0	0	0	0
Trifolium repens subsp. *prostratum* Nyman	62	7	5	2	1	0	0	0
Trifolium repens L. var. *repens*	3189	18	12	9	5	0	0	0
Trifolium resupinatum L.	2548	26	23	627	15	424	11	9
Trifolium resupinatum var. *majus* Boiss.	107	7	8	0	0	0	0	0
Trifolium resupinatum L. var. *resupinatum*	105	8	6	0	0	0	0	0

Scientific name	Population occurrences with coordinates	No. of CWR-Eco	No. of countries	Total No. seed accessions	No. of countries	No. seed accessions with coordinates	No. of CWR-Eco units	No. of countries
Trifolium squarrosum L.	99	8	5	33	5	16	4	4
Trifolium subterraneum L.	4263	22	21	12242	19	7553	17	14
Trifolium subterraneum subsp. *oxaloides* Nyman	13	3	2	0	0	0	0	0
Trifolium subterraneum subsp. *yanninicum* Katzn. & F. H. W. Morley	0	0	0	0	0	0	0	0
Trifolium vesiculosum Savi	64	10	11	122	6	38	5	5
Trigonella foenum-graecum L.	95	14	14	73	13	18	4	4
Trisetum flavescens (L.) P. Beauv.	20712	21	27	56	17	29	7	8
Trisetum flavescens subsp. *baregense* (Laffitte & Miégev.) O. Bolòs & al.	0	0	0	0	0	0	0	0
Trisetum flavescens subsp. *corsicum* (Rouy) Cif. & Giacom.	3	1	1	0	0	0	0	0
Trisetum flavescens (L.) P. Beauv. subsp. *flavescens*	1551	14	9	0	0	0	0	0
Trisetum flavescens subsp. *purpurascens* (DC.) Arcang.	28	10	5	0	0	0	0	0
Trisetum flavescens subsp. *serbicum* (Velen.) Hayek	0	0	0	0	0	0	0	0
Trisetum flavescens subsp. *splendens* (C. Presl) Arcang.	15	3	1	0	0	0	0	0
Trisetum flavescens subsp. *tenue* (Formánek) Strid	14	3	1	0	0	0	0	0
Triticum monococcum L.	450	12	11	2037	21	1232	10	14
Triticum monococcum subsp. *aegilopoides* (Link) Thell.	124	9	6	134	6	63	3	1
Triticum monococcum subsp. *sinskajae* (A. A. Filatenko & U. K. Kurkiev) Valdés & H. Scholz	0	0	0	0	0	0	0	0

Scientific name	Population occurrences with coordinates	No. of CWR-Eco	No. of countries	Total No. seed accessions	No. of countries	No. seed accessions with coordinates	No. of CWR-Eco units	No. of countries
Triticum timopheevii (Zhuk.) Zhuk.	17	5	3	65	12	28	7	4
Triticum timopheevii subsp. *armeniacum* (Jakubz.) Mackey	8	4	1	4	2	0	0	0
Triticum turgidum L.	584	19	15	725	20	496	12	10
Triticum turgidum subsp. *asiaticum* (Vavilov) H. Scholz	0	0	0	0	0	0	0	0
Triticum turgidum subsp. *dicoccoides* (Asch. & Graebn.) Thell.	11	3	1	0	0	0	0	0
Triticum turgidum subsp. *subspontaneum* (Tzvelev) Valdés & H. Scholz	0	0	0	0	0	0	0	0
Triticum turgidum subsp. *volgense* (Flaksb.) Á Löve & D. Löve	0	0	0	0	0	0	0	0
Vaccinium corymbosum L.	142	8	9	1	1	1	0	1
Vaccinium macrocarpon Aiton	35	4	3	0	0	0	0	0
Vaccinium oxycoccos L.	24277	11	21	105	7	66	3	4
Vicia anatolica Turrill	14	5	2	90	3	12	4	1
Vicia articulata Hornem.	163	6	7	124	11	79	4	4
Vicia barbazitae Ten. & Guss.	41	4	4	2	1	2	1	1
Vicia benghalensis L.	752	19	7	115	9	24	7	5
Vicia bithynica (L.) L.	936	19	17	134	12	96	11	9
Vicia capreolata Lowe	0	0	0	0	0	0	0	0
Vicia ciliatula Lipsky	15	4	3	0	0	0	0	0
Vicia costae A. Hansen	0	0	0	0	0	0	0	0
Vicia cuspidata Boiss.	100	6	2	113	2	82	5	2
Vicia eristalioides Maxted	5	1	1	5	1	5	1	1
Vicia ervilia (L.) Willd.	293	12	11	736	20	366	12	10

Scientific name	Population occurrences with coordinates	No. of CWR-Eco	No. of countries	Total No. seed accessions	No. of countries	No. seed accessions with coordinates	No. of CWR-Eco units	No. of countries
Vicia ferreirensis Goyder	2	1	1	0	0	0	0	0
Vicia grandiflora Scop.	642	12	20	99	9	51	7	7
Vicia grandiflora Scop. var. *grandiflora*	66	6	10	0	0	0	0	0
Vicia hirsuta (L.) Gray	32641	28	27	169	18	69	9	11
Vicia hybrida L.	1196	14	11	523	12	390	11	5
Vicia hyrcanica Fisch. & C. A. Mey.	4	4	2	10	3	4	2	2
Vicia johannis Tamamsch.	166	12	9	157	4	71	6	3
Vicia johannis Tamamsch. var. *johannis*	12	5	3	2	2	2	2	2
Vicia johannis var. *procumbens* H. I. Schafer	29	3	1	25	1	24	3	1
Vicia lathyroides L.	4774	17	23	99	11	61	7	7
Vicia lutea L.	2260	18	17	280	13	143	9	5
Vicia lutea L. subsp. *lutea*	498	14	10	2	2	2	2	2
Vicia lutea subsp. *vestita* (Boiss.) Rouy	186	6	8	36	3	35	5	3
Vicia melanops Sibth. & Sm.	177	10	9	45	7	31	3	3
Vicia melanops Sibth. & Sm. var. *melanops*	10	3	4	0	0	0	0	0
Vicia mollis Boiss. & Hausskn.	40	5	1	45	1	33	4	1
Vicia narbonensis L.	429	18	17	457	20	179	10	7
Vicia narbonensis var. *affinis* Asch. & Schweinf.	19	4	1	25	1	25	4	1
Vicia narbonensis L. var. *narbonensis*	10	4	2	14	4	13	5	4
Vicia narbonensis var. *salmonea* (Mouterde) H. I. Schafer	4	2	1	3	1	3	1	1
Vicia pannonica Crantz	749	13	20	204	15	45	7	8
Vicia pannonica Crantz subsp. *pannonica*	123	9	13	3	2	3	3	2
Vicia pannonica subsp. *striata* (M. Bieb.) Nyman	472	13	13	5	3	5	4	3
Vicia pectinata Lowe	0	0	0	0	0	0	0	0

Scientific name	Population occurrences with coordinates	No. of CWR-Eco	No. of countries	Total No. seed accessions	No. of countries	No. seed accessions with coordinates	No. of CWR-Eco units	No. of countries
Vicia pyrenaica Pourr.	257	10	2	28	2	25	3	1
Vicia sativa L.	27565	30	34	4476	34	1435	19	21
Vicia sativa subsp. *amphicarpa* (Dorthes) Asch.	179	10	5	14	3	13	5	2
Vicia sativa subsp. *cordata* (Hoppe) Batt.	175	9	12	31	4	30	4	4
Vicia sativa subsp. *devia* J. G. Costa	0	0	0	0	0	0	0	0
Vicia sativa subsp. *incisa* (M. Bieb.) Arcang.	13	4	4	1	1	0	0	0
Vicia sativa subsp. *macrocarpa* (Moris) Arcang.	61	6	6	47	5	34	4	4
Vicia sativa subsp. *nigra* (L.) Ehrh.	24731	29	31	119	15	83	14	13
Vicia sativa var. *platysperma* Barulina	0	0	0	0	0	0	0	0
Vicia serratifolia Jacq.	134	11	14	30	8	1	1	1
Vicia villosa Roth	3429	22	25	591	26	210	17	11
Vicia villosa subsp. *ambigua* (Guss.) Kerguélen	278	7	6	1	1	0	0	0
Vicia villosa subsp. *eriocarpa* (Hausskn.) P. W. Ball	360	6	8	40	3	39	5	2
Vicia villosa subsp. *microphylla* (d'Urv.) P. W. Ball	186	6	3	0	0	0	0	0
Vicia villosa subsp. *varia* (Host) Corb.	1261	16	21	51	8	25	6	4
Vicia villosa Roth subsp. *villosa*	1341	15	16	19	6	18	10	6
Vitis acerifolia Raf.	4	2	2	0	0	0	0	0
Vitis amurensis Rupr.	22	0	1	38	3	0	0	0
Vitis labrusca L.	81	11	6	0	0	0	0	0
Vitis riparia Michx.	39	8	6	53	2	0	0	0
Vitis rupestris Scheele	112	7	3	0	0	0	0	0
Vitis vinifera L.	3325	23	26	732	11	28	2	4
Vitis vulpina L.	100	6	3	0	0	0	0	0

Annex D: Top 50 Natura 2000 sites richest in CWR priority taxa

SITECODE	Natura 2000 site name	Country	Richness in CWR priority taxa	No. of populations
ES0000468	Serra d'Espadá (SPBA)	Spain	118	2973
FR8312011	Pays des Couzes	France	118	442
ES0000035	Sierras de Cazorla, Segura y Las Villas	Spain	114	794
BE2300006	Schelde- en Durme-Estuarium van de Nederlandse grens tot Gent	Belgium	113	2113
FR8312002	Haut Val d'Allier	France	111	436
FR9301608	Mont Caume - mont Faron - forêt domaniale des Morières	France	111	257
FR8201657	Moyenne vallée de l'Ardèche, pelouses du plateau des Gras	France	111	114
FR9302007	Valensole	France	110	552
FR2601012	Gîtes et habitats à chauves-souris en Bourgogne	France	109	2218
BE2500001	Duingebieden inclusief Ijzermonding en Zwin.	Belgium	109	1323
DE7132371	Mittleres Altmühltal mit Wellheimer Trockental und. Schambachtal	Germany	108	270
NL2014038	Rijntakken	The Netherlands	107	3303
IT5120019	Monte Pisano	Italy	107	331
FR9301622	La plaine et le massif des Maures	France	107	247
FR8312009	Gorges de la Loire	France	106	346
DE6029371	Buchenwälder und Wiesentäler des Nordsteigerwalds	Germany	105	2130
DE5726371	Wälder und Trockenstandorte bei Bad Kissingen und Münnerstadt	Germany	105	1528
BE2300007	Bossen van de Vlaamse Ardennen en andere Zuidvlaamse bossen.	Belgium	104	1937
FR9112004	Hautes Garrigues du Montpelliérais	France	104	320
FR2402001	Sologne	France	103	3270
FR2612001	Arrière côte de Dijon et de Beaune	France	103	2055
ES0000449	Alto Turia y Sierra del Negrete	Spain	102	3544
DE5929371	Haßbergetrauf von Zeil am Main bis Königsberg	Germany	102	911
IT5150001	La Calvana	Italy	102	261

SITECODE	Natura 2000 site name	Country	Richness in CWR priority taxa	No. of populations
FR9301589	La Durance	France	102	168
DE5526471	Bayerische Hohe Rhön	Germany	101	2076
IT5140008	Monte Morello	Italy	101	241
ES5223004	Penyagolosa	Spain	100	1307
FR1100795	Massif de Fontainebleau	France	100	382
FR5212002	Vallée de la Loire de Nantes aux Ponts-de-Cé et ses annexes	France	100	223
FR8201785	Pelouses, milieux alluviaux et aquatiques de l'île de Miribel-Jonage	France	100	108
FR8201654	Basse Ardèche urgonienne	France	100	102
DE6027472	Schweinfurter Becken und nördliches Steigerwaldvorland	Germany	99	570
FR9302008	Vachères	France	99	299
BE2400014	Demervallei	Belgium	98	1467
ES6140004	Sierra Nevada	Spain	98	486
FR4201797	Secteur Alluvial Rhin-Ried-Bruch, Bas-Rhin	France	98	289
FR4301294	Moyenne Vallée du Doubs	France	98	177
FR9310110	Plaine des Maures	France	98	116
NL2014067	Rijntakken	The Netherlands	97	3497
DE6426471	Ochsenfurter und Uffenheimer Gau und Gäulandschaft Nö Würzburg	Germany	97	1114
ES5233001	Tinença de Benifassá, Turmell i Vallivana	Spain	97	1105
FR9301605	Montagne Sainte Victoire	France	97	255
DE6836371	Schwarze Laaber	Germany	97	221
NL3009017	Veluwe	The Netherlands	96	4615
ES0000474	Serres de Mariola i el Carrascal de la Font Roja (SPBA)	Spain	96	951
BE33042C0	Vallées de la Warche et du Bayehon en aval du barrage de Robertville	Belgium	96	116
DE5728471	Haßbergetrauf und Bundorfer Wald	Germany	95	1059
ES5213042	Valls de la Marina	Spain	95	661

SITECODE	Natura 2000 site name	Country	Richness in CWR priority taxa	No. of populations
FR9101446	Vallée du Lampy	France	95	174

Annex E: Top 50 complementary protected areas in Europe and Turkey for CWR-Eco conservation

Type of Protected Area	Area Identifier	Site Name	Release Date	Country	Type of area	No. CWR-Eco units
WDPA	396111	Lsg Innerhalb Des Naturparks Spessart (Ehemals Schutzzone)	1982	Germany	Landscape Protection Area	512
WDPA	555561971	Baronnies Provençales	2015	France	Regional Nature Park	237
WDPA	20642	Ballons Des Vosges	1989	France	Regional Nature Park	166
N2000	ES0000468	Serra d'Espadà (SPBA)	2019/12/13	Spain		161
WDPA	103154	Mercantour [Aire D'Adhésion]	1979	France	National Park - Buffer Zone/Area Of Adhesion	147
WDPA	555638689	Nnn-Nh - Nature Reserves owned by professional Nature Management Organizations	2018	The Netherlands	Nature Reserves Owned By Professional Nature Management Organizations	127
WDPA	344573	Troodos Range To South West Shores	2014	Cyprus	Areas Of Special Aesthetic Value	120
N2000	PTZPE0023	Caldeira e Capelinhos - Ilha do Faial, Azores	2019/12/05	Portugal		103
N2000	BE2500001	Duingebieden inclusief Ijzermonding en Zwin.	2018/12/14	Belgium		90
WDPA	6313	Vercors	1970	France	Regional Nature Park	88
N2000	FR5410100	Marais poitevin	2020/01/22	France		79
N2000	FR8210032	La Vanoise	2020/01/22	France		78
WDPA	396113	Lsg "Bayerische Rhön"	1983	Germany	Landscape Protection Area	73
N2000	FR9301592	Camargue	2020/01/22	France		72
N2000	ES0000049	Los Alcornocales	2019/12/13	Spain		71
WDPA	388966	Furnas	2008	Portugal	Protected Landscape	67
WDPA	12396	Livradois-Forez	1986	France	Regional Nature Park	62
WDPA	555545797	Pico do Boi	2011	Portugal	Habitats Or Species Management Protected Area	57

Type of Protected Area	Area Identifier	Site Name	Release Date	Country	Type of area	No. CWR-Eco units
N2000	ES6110005	Sierra de Cabrera-Bédar	2019/12/13	Spain		45
N2000	DE8528301	Allgäuer Hochalpen	2019/12/13	Germany		45
WDPA	964	Brecon Beacons	1951	United Kingdom	National Park	44
WDPA	388908	Zona Central (Ilha do Faial), Azores	2008	Portugal	Protected Landscape	44
WDPA	388939	Barreiro Da Faneca, (Ilha de Santa Maria, Azores)	2005	Portugal	Protected Landscape	42
N2000	FI1101645	Oulanka	2019/09/17	Finland		40
WDPA	181712	La Narbonnaise En Méditerranée	2003	France	Regional Nature Park	38
N2000	ES6140004	Sierra Nevada	2019/12/13	Spain		37
N2000	ES0000114	Cumbres y acantilados del norte de La Palma	2019/12/13	Spain		36
N2000	GR4210029	Anatoliki rodos: Profitis Ilias – Epta piges – Ekvoli Loutoni - Katergo, Rema Gadoura – Cheronisos Lindou – Nisides Pentanisa Kai Tetrapolis, Lofos Psalidi	2019/12/15	Greece		35
WDPA	83231	Ecrins [Aire D'Adhésion]	1973	France	National Park - Buffer Zone/Area Of Adhesion	34
N2000	ES0000471	l'Albufera (SPBA)	2019/12/13	Spain		33
N2000	FR9112022	Est et sud de Béziers	2020/01/22	France		30
WDPA	145591	Teberda	1997	Russia	UNESCO-MAB Biosphere Reserve	30
WDPA	349977	Periochi Perivallontikou Elegchou Ethnikou Parkou Ygrotopon Amvrakikou (Zoni C)	2008	Greece	National Park - Peripheral Zone	28
N2000	BE33042C0	Vallées de la Warche et du Bayehon en aval du barrage de Robertville	2018/12/14	Belgium		28
WDPA	103151	Pyrénéees [Aire D'Adhésion]	1967	France	National Park - Buffer Zone/Area Of Adhesion	25
WDPA	6315	Luberon	1977	France	Regional Nature Park	24
N2000	ES6130002	Sierras Subbéticas	2019/12/13	Spain		22
WDPA	396109	Verordnung über Die Landschaftsschutzgebiete Im Landkreis Regensburg	1989	Germany	Landscape Protection Area	22

Type of Protected Area	Area Identifier	Site Name	Release Date	Country	Type of area	No. CWR-Eco units
WDPA	555711926	Russkij Sever	1992	Russia	National Park	22
WDPA	20628	Suffolk Coast & Heaths	1970	United Kingdom	Area Of Outstanding Natural Beauty	21
N2000	ES6130007	Guadiato-Bembézar	2019/12/13	Spain		20
WDPA	103145	Chartreuse	1995	France	Regional Nature Park	20
WDPA	396122	Lsg Innerhalb Des Naturparks Hassberge (Ehemals Schutzzone)	1987	Germany	Landscape Protection Area	20
WDPA	6317	Corse	1972	France	Regional Nature Park	19
N2000	SE0420075	Verkeåns dalgång	2019/01/14	Sweden		19
WDPA	1754	Karadagskiy	1979	Ukraine	Nature Zapovednik	18
N2000	ES0000109	Anaga	2019/12/13	Spain		18
WDPA	389027	Turia	2007	Spain	Natural Park	17
N2000	NL3009017	Veluwe	2019/05/21	The Netherlands		17
N2000	FR9301497	Plateau d'Emparis - Gole	2020/01/22	France		17