Identification and assessment of the crop wild relatives of Spain that require most urgent conservation actions.

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Abstract. Crop Wild Relatives (CWR) are receiving significant attention over the last decades. Numerous conservation plans and guidelines to better manage these resources have been developed lately at both national and international levels. In this sense, Spain is following a similar path to that followed by other countries and has included CWR in the National Strategy for Plant Conservation of Spain and invested in scientific projects dealing with their conservation.

In this work, we present a preliminary assessment of the conservation status (both in situ and ex situ) of the Spanish CWR that are in a most urgent need of conservation. Crossability to crops, endemicity, threat status according to IUCN standards and high-quality georeferenced occurrence data were the criteria applied to select the target species, generating a list of 47 CWR species. Eleven of them, classified as Critically Endangered or Endangered by IUCN criteria are not, and should be, included in the National Catalogue of Threatened Species of Spain; however 35 of them are included in at least one autonomous catalogue. Seventy-five per cent of the species are represented in protected areas, but if a minimum of five populations inside protected areas is sought the representation decreases to a 37%. The preliminary assessment of ex situ conservation shows that a high percentage of the species (81%) has at least one accession in national or international germplasm banks. However, additional studies are needed to determine if the accessions included in germplasm banks provide an adequate representation of the genetic variability of the species.

Keywords: Threatened; endemic; conservation status; crop wild relatives.
of the Global Strategy for Plant Conservation outlined by the Convention on Biological Diversity (UN CBD). The generation and publication of multiple lists and inventories of CWR all over the world endorses this assertion; among others, there are inventories for the United Kingdom (Maxted & al., 2007), Venezuela (Berlinger & Crespo, 2012), the United States (Khoury & al., 2013), China (Kell & al., 2014), Italy (Landucci & al., 2014), Cyprus (Phillips & al., 2014), England (Fielder & al., 2015a); Scotland (Fielder & al., 2015b), Norway (Phillips & al., 2016), The Netherlands (van Treuren & al., 2017), the Czech Republic (Taylor & al., 2017), Spain (Rubio Teso & al., 2018) and even a global one (Vincent & al., 2013). As any other wild species, CWR populations are threatened by habitat fragmentation, loss of habitat or genetic erosion (Heywood, 2011; Kell & al., 2012; Maxted & al., 2010, 2012), therefore conservation measures are needed to maintain their genetic diversity and avoid extinction. In Spain, the creation of the National Catalogue of Threatened Species promoted by Royal Decree 139/2011 (BOE n. 46, 23/02/2011), provides the ultimate framework to design and implement a conservation plan for endangered species. Additionally, the autonomous communities in which Spain is structured have enacted legislation comprising Regional Catalogues of Threatened Species that confer protection within their territorial limits. The inclusion of a species in these catalogues implies legal protection and the commitment by the administrations to elaborate periodic assessments of its conservation status and implement conservation measures. The in situ conservation of Spanish CWR could be approached using the Natura 2000 network. This network was designed in 1992 under the Habitats Directive (Council Directive 92/43/EEC) seeking the creation of a transnational system in Europe to protect both species and their habitats. Consequently, it may provide an effective way to confer passive conservation to CWR populations in Spain. In addition, it could facilitate the drafting of CWR genetic reserves in which their genetic diversity could be more actively preserved (Iriondo & al., 2008; Maxted & al., 2008). On the other hand, the ex situ conservation of seeds in germplasm collections can prevent the loss of genetic diversity of plant species (Bacchetta & al., 2008). Thus, it should be considered as a complementary system to the in situ conservation.

The compilation of CWR information on threat status, endemicity and crossability with crops can help in implementing conservation plans and directing efforts in the right way. In this sense, Rubio Teso & al. (2018) generated a prioritized CWR list for Spain containing 578 species. Still 578 species is a large number of species to consider for the implementation of conservation measures. Hence, it arises the need of identifying the CWR species which most urgently need conservation actions and assessing their conservation status. The aim of this paper is to generate information that may help in ordering priorities for CWR conservation in Spain and implementing conservation actions. Thus, we pose the following questions: Which are the CWR in most urgent need of conservation? Are these species legally protected? What is the in situ conservation status of their populations? Are these species conveniently represented in germplasm banks?

**Materials & Methods**

**Selection of species**

The selection of species aimed at identifying the crop wild relatives that were in most urgent need of knowing their conservation status and of implementing conservation actions. Thus, using as reference the Prioritized Spanish Checklist of Crop Wild Relatives (578 species; Rubio Teso & al., 2018), a strict filtering was made to include just those species which simultaneously: a) were threatened under any of the IUCN categories according to the Spanish Red List of Vascular Flora (Moreno, 2008), b) were endemic to Spain, and c) had high crossability potential with crops of reference, belonging to genepool concept levels 1 or 2 (Harlan & de Wet, 1971) or taxon group concept levels 2 or 3 (Maxted & al., 2006). These three criteria, call attention to three key factors: threat, uniqueness and facility of use for breeding purposes.

Distribution data for the resulting species were downloaded from the GBIF data portal (GBIF, 2011-2013), filtering by scientific name and country (Spain). Synonyms were taken into account and included in the search. Quality of the georeferencing data was evaluated to be able to provide an accurate estimate on whether the populations of the target species fell within limits of protected areas. Consequently, data lacking locality description, geographic coordinates or with geographic coordinates with less than two decimals of decimal degrees (around 1 km accuracy) were eliminated from the analysis. Duplicates based on geographic coordinates were also eliminated. Only species with distribution data with the minimum quality standards established were selected and taken into account for further analysis.

**Legal protection of the target species**

To assess whether any of the target species were under legal protection in Spain, the Spanish National Catalogue of Threatened Species promoted by Royal Decree 139/2011 (BOE n 46, 23/02/2011) was checked. In addition, the Regional Catalogues of Threatened Species from all seventeen autonomous communities in Spain were consulted in order to verify their protection at the subnational level.

**In situ and ex situ conservation preliminary assessment of the target species**

A gap analysis (Scott & al., 1993) is a useful approach used to assess the representation of biological components in protected areas. This analysis provides a rough estimation of the in situ conservation status of a given species. However, it must be noted that while occurrence data confirms the presence of a species in a given territory, the lack of occurrence data does not necessarily mean the absence of the species. Once this premise was established,
Selection of target species

The selection of species according to the established criteria, including the georeferencing quality criterion, generated a list of 47 species. If this last criterion had not been taken into account, 26 additional species would have been included. Results indicate that the CWR species in most urgent need of conservation assessment belong predominantly to the ornamental category use (Table 1) and to the Plumbaginaceae (40%), Lamiaceae (19%) and Amaryllidaceae (15%) families. The species were not evenly distributed among the three most endangered IUCN categories, as almost half of the species belonged to the Vulnerable category (22 species), followed by the Critically Endangered category (12 species), the Endangered category (eight species) and finally by the Near Threatened category (22 species), with 699 records in total. Figure 1 depicts the distribution of these occurrences in Spain.

The analysis was performed using ArcGIS software, v. 10.1 (ESRI, USA). The number of populations for each species after georeferencing quality data assessment and of those within the Sites of Community Importance were added to the database of the study.

Brown & Briggs (1991) considered that the adequate preservation of the genetic diversity of an endangered species requires conservation of a minimum of five populations. On the other hand, Whitlock & al. (2016) established that 35% of the populations of a species are needed to conserve 70% of its genetic diversity. Consequently, these two thresholds were considered for the conservation assessment of this study.

Simultaneously, ex situ conservation status was assessed consulting different national and international databases. Again, the absence of data in the searched databases does not necessarily mean that there are no accessions preserved anywhere else, but that data are not available or public. Databases consulted were: I) the Spanish network of autochthonous plant genetic resources and wild plant germplasm banks (REDBAG), which belongs to the Iberian-Macaronesian Association of Botanical Gardens; II) the European Search Catalogue for Plant Genetic Resources (EURISCO), and III) the GRIN-USDA database belonging to the United States National Plant Germplasm System (GRIN-USDA). Information on number of accessions were not accessible in all sources consulted. Thus, the assessment focused on the presence/absence of accessions of the target species in germplasm collections.

Legal protection of target species

Ten of the 47 target CWR species are included in the Spanish National Catalogue of Threatened Species, which represent around 21% of the species of this study. Four of them are classified in this catalogue as “in danger of extinction”, four as “protected” and two as “vulnerable”. Thirty-five species (around 74% of the species of this study) are included in at least one of the regional catalogues. From these, six species are present in two regional catalogues. Eleven species from our list are classified into the highest IUCN threat categories (Critically Endangered and Endangered) but not included in the National Catalogue of Threatened Species; however, all of them except for Sideritis reverchoni Willk., are included in the regional catalogues (see Table 2).

Preliminary in situ and ex situ conservation assessment of target species

The application of the georeferencing data quality criteria produced a final occurrence dataset for 47 species, with 699 records in total. Figure 1 depicts the distribution of these occurrences in Spain.

The in situ gap analysis showed that 39% of the recorded populations of the target species were inside protected areas (Table 3). On the other hand, 36 target species (74%) have at least one of their populations within the limits of the Sites of Community Importance, and 18 species (38%) five or more populations. The application of the threshold involving the conservation of 35% of the populations showed that 27 species (57%) would comply with this requisite.

Regarding ex situ conservation, 40 species (85%) have at least one accession preserved in national and international germplasm collections (Table 3). The coverage of the ex situ conserved species was quite akin along the IUCN categories.
<table>
<thead>
<tr>
<th>Category</th>
<th>Family</th>
<th>Species</th>
<th>Th.</th>
<th>NP</th>
<th>NP SCI</th>
<th>% SCI</th>
<th>Germ. banks</th>
<th>Nat. Cat.</th>
<th>Aut. Cat.</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Asteraceae</td>
<td><em>Argyranthemum broussonetti</em> (Pers.) Humphries</td>
<td>VU</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Argyranthemum callichrysum</em> (Svent.) Humphries</td>
<td>VU</td>
<td>3</td>
<td>2</td>
<td>66.7</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>VU</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Argyranthemum maderense</em> (D. Don) Humphries</td>
<td>VU</td>
<td>2</td>
<td>1</td>
<td>50</td>
<td>no</td>
<td>yes(CAN/IE)</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Argyranthemum winteri</em> (Svent.) Humphries</td>
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<td>1</td>
<td>0</td>
<td>0</td>
<td>yes(Yes/VU)</td>
<td>yes(CAN/VU)</td>
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</tr>
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<td>Caryophyllaceae</td>
<td></td>
<td><em>Dianthus toletanus</em> Boiss. &amp; Reut.</td>
<td>NT</td>
<td>10</td>
<td>5</td>
<td>50</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
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<td></td>
<td><em>Limonium album</em> (Coincy) Sennen Quer</td>
<td>VU</td>
<td>12</td>
<td>6</td>
<td>50</td>
<td>no</td>
<td>yes(MUR/VU)</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Limonium aragonense</em> (Debeaux) Kuntze Hubb. &amp; Sandwith</td>
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<td>5</td>
<td>2</td>
<td>40</td>
<td>yes(ARA/SH)</td>
<td>no</td>
<td>yes(CAT/VU)</td>
</tr>
<tr>
<td></td>
<td>Plumbaginaceae</td>
<td><em>Limonium arborescens</em> (Brousse) Kuntze</td>
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<td>1</td>
<td>0</td>
<td>0</td>
<td>yes(PR)</td>
<td>yes(CAN/IE)</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Limonium carthaginense</em> (Rouy) C. E.</td>
<td>VU</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>no</td>
<td>yes(MUR/VU)</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Limonium catalaunicum</em> (Willk. &amp; Costa) Pignatti</td>
<td>CR</td>
<td>28</td>
<td>3</td>
<td>10.7</td>
<td>yes</td>
<td>no</td>
<td>yes(ARA/SI) (CAT/DE)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Limonium dufourei</em> (Girard) Kuntze</td>
<td>CR</td>
<td>6</td>
<td>1</td>
<td>16.7</td>
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<td>yes(VAL/DE)</td>
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<td>yes(CAT/DE)</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>12</td>
<td>10</td>
<td>83.3</td>
<td>yes</td>
<td>yes(AND/DE)</td>
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</tr>
<tr>
<td></td>
<td></td>
<td><em>Limonium fruticans</em> (Webb) Kuntze</td>
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<td>2</td>
<td>0</td>
<td>0</td>
<td>yes(PR)</td>
<td>yes(CAN/IE)</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>VU</td>
<td>2</td>
<td>1</td>
<td>50</td>
<td>no</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>VU</td>
<td>44</td>
<td>16</td>
<td>36.4</td>
<td>no</td>
<td>no</td>
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<td></td>
<td><em>Limonium santapolense</em> Erben</td>
<td>ERBEN</td>
<td>9</td>
<td>1</td>
<td>11.1</td>
<td>yes</td>
<td>yes(VAM/MS)</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Limonium subglabrum</em> Erben</td>
<td>EN</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>yes</td>
<td>yes(AND/SP)</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Limonium tabernense</em> Erben</td>
<td>VU</td>
<td>15</td>
<td>11</td>
<td>73.3</td>
<td>yes</td>
<td>yes(AND/RP)</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Limonium thiinense</em> Erben</td>
<td>VU</td>
<td>12</td>
<td>5</td>
<td>42</td>
<td>yes</td>
<td>yes(VAM/MS)</td>
<td>no</td>
</tr>
<tr>
<td>Amaryllidaceae</td>
<td></td>
<td><em>Limonium tremolsii</em> (Rouy) Erben</td>
<td>ERBEN</td>
<td>4</td>
<td>3</td>
<td>75</td>
<td>yes</td>
<td>yes(CAT/AC)</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Narcissus alcaracensis</em> Rios &amp; al.</td>
<td>EN</td>
<td>4</td>
<td>3</td>
<td>75</td>
<td>yes</td>
<td>yes(CLIM/VU)</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Narcissus bugei</em> (Fern. Casas) Fern. Casas</td>
<td>VU</td>
<td>10</td>
<td>1</td>
<td>10</td>
<td>yes</td>
<td>no</td>
<td>yes(AND/RP)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Narcissus eugeniae</em> Fern. Casas</td>
<td>VU</td>
<td>2</td>
<td>1</td>
<td>50</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Narcissus longispatus</em> Pugsley</td>
<td>EN</td>
<td>10</td>
<td>6</td>
<td>60</td>
<td>yes</td>
<td>yes(DE)</td>
<td>no</td>
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<tr>
<td></td>
<td></td>
<td><em>Narcissus nevadensis</em> Pugsley enemeritoi Sánchez-Gómez &amp; al.</td>
<td>CR</td>
<td>5</td>
<td>5</td>
<td>100</td>
<td>yes</td>
<td>yes(DE)</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Narcissus tortifolius</em> Fern. Casas</td>
<td>VU</td>
<td>16</td>
<td>10</td>
<td>62.5</td>
<td>yes</td>
<td>yes(AND/VU) (MU/DE)</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Narcissus yepesi</em> Rios &amp; al.</td>
<td>VU</td>
<td>5</td>
<td>4</td>
<td>80</td>
<td>yes</td>
<td>yes(AND/VU) (MU/DE)</td>
<td>no</td>
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<tr>
<td>Fabaceae</td>
<td></td>
<td><em>Astragalus cavanillesii</em> Podlech</td>
<td>CR</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>no</td>
<td>yes(CLIM/VU) (MU/VU)</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Astragalus fremontianus</em> Pau</td>
<td>CR</td>
<td>6</td>
<td>6</td>
<td>100</td>
<td>yes</td>
<td>yes(AND/DE)</td>
<td>no</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Medicago alba</em> (Font Quer) Greater</td>
<td>VU</td>
<td>21</td>
<td>9</td>
<td>42.9</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
</tbody>
</table>
Finally, two species (*Astragalus cavanillesii* Podlech and *Sideritis reverchonii* Willk.) have no populations within the limits of the Sites of Community Importance of the Natura 2000 network, nor accessions in germplasm banks. It is remarkable that these two species classified respectively as Critically Endangered and Endangered in the Spanish Red List of Vascular Flora are not included into the National Catalogue of Threatened Species of Spain, although *A. cavanillesii* is included in the catalogues of Castilla La Mancha and Región de Murcia (see Table 2).

Table 3. *In situ*, *ex situ* and legal conservation status of target CWR species of Spain (T CWR). For abbreviations on the rest of variables see Table 2.

<table>
<thead>
<tr>
<th>Th.</th>
<th>T CWR</th>
<th>NP SCI</th>
<th>% SCI</th>
<th>Germ. banks</th>
<th>Nat. Cat.</th>
<th>Aut. Cat.</th>
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<tbody>
<tr>
<td>CR</td>
<td>12</td>
<td>9</td>
<td>42</td>
<td>9</td>
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<td>4</td>
<td>25</td>
<td>7</td>
<td>3</td>
<td>7</td>
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<tr>
<td>VU</td>
<td>22</td>
<td>18</td>
<td>39</td>
<td>20</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
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<td>5</td>
<td>55</td>
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</tr>
<tr>
<td>TOTAL</td>
<td>47</td>
<td>36</td>
<td>39</td>
<td>40</td>
<td>10</td>
<td>35</td>
</tr>
</tbody>
</table>

**Discussion**

**Selection of species**

The Mediterranean area is a region with high speciation rates and endemicity (Medail & Quezel, 1999; Thompson, 2005) and the Iberian Peninsula shelters more than 30% of European endemic species (Araújo & al., 2007). Thus, it is not surprising that 13% of the prioritized CWR of Spain (Rubio Teso & al., 2018) fulfilled the targeted criteria of being both threatened and endemic. The lack of available high-quality data for 26 of these species reduced this percentage to 8%. This lack of publicly available data does not mean it does not exist and can be simply explained by the zeal of some administrations in sharing sensitive data that could menace the survival of the populations. Thus, it has been a common procedure that projects focused on the study of threatened plants provide low-resolution occurrence data to chorological databases to preserve the location from unwanted visits (e.g. AFA project (Bañares & al., 2001)). We must also highlight that some of the occurrence data may be outdated as sources used include very old records. Nevertheless, the selection carried out of georeferencing data of high quality eliminated most of the old records. In any case, the work with endemic and threatened species requires up-to-date data that reflect the real distribution status of the analysed species. Thus, records over ten-years old should be revisited and their occurrence confirmed, at least for the most endangered species.

The selection of target species in this study clearly favours species included in the Ornamental category (32 species). This can be explained by the fact that genera selected from this category (particularly *Limonium* Mill. and *Narcissus* L.) are highly diversified and narrowly distributed and thus, with higher number of endemics and threatened...
species. In addition, these genera have their centers of diversity in the Mediterranean basin (Crespo, 2009; Raimondo, 1993; Roselló & al., 1994; Santos-Gally & al., 2012; Simón & al., 2010), and are probably responsible for the Eastern distribution of the occurrences shown in Figure 1.

Figure 1. Distribution of the occurrence data of target threatened and endemic CWR of Spain. Grey areas correspond to Sites of Community Interest – Natura 2000.

Legal protection of target species

Thirty-seven target species considered to be in different levels of threat according to the Spanish Red List of Vascular Flora (Moreno, 2008) are not included in the National Catalogue as scientific information concerning threatened species is made available. However, results show that more than 74% of the CWR target species are included in the regional catalogues which provide further protection. On the other hand, eleven of the CWR species classified in the two highest IUCN threat categories are not found in the National Catalogue although 10 of them are in the regional catalogues. The inclusion of these species into regional catalogues demonstrate the engagement of the autonomous administrations in preserving their autochthonous flora, as a first step to start protecting our flora. Still, the inclusion of these species into the regional catalogues does not suppress the need to include them in the National Catalogue. The national administration is also giving steps in this sense and committed to increment knowledge about threatened plants, as manifested through the concatenation of different projects dealing with the study of threatened plant species in Spain, i.e., the Atlas and Red Book of Vascular Flora of Spain (Bañares & al., 2004), the collection of germplasm and development of management protocols for protected plants of Spain project (ref: TEC0004223-TRAGSATEC) or the SEFA project (http://www.conservacionvegetal.org/proyectos.php). Results from our study stress the need of implementing conservation actions for the eleven species in the highest IUCN categories and not included in the National Catalogue, particularly focusing on Astragalus cavanillesii Podlech and Sideritis reverchonii Willk., which have no known populations within protected areas or seed accessions in germplasm banks. Special attention should be given to S. reverchonii, which is not included in any of the regional catalogues of threatened flora either.

In situ and ex situ conservation preliminary assessment of target species

Different assessments of the Natura 2000 network have been reported concerning the conservation of different biological entities in Spain (Martínez & al., 2006; Araújo & al., 2007; Rubio-Salcedo & al., 2013). Whilst Araújo
& al. (2007) found acceptable representation (73-98% depending on the used criteria) of plant and animal species (pteridophytes, gymnosperms, dicotyledons, monocotyledons, reptiles, amphibians, birds and mammals), Rubio-Salcedo & al. (2013) concluded a poor coverage of lichen species based on the percentage of the potential distribution area present in the network. The representation of the target CWR of our study in the Natura 2000 network was around the lower range of values presented by Araújo & al. (2007). This can be explained by the much higher resolution of the data we have used (1 km vs. 50 km) and the stricter criterion applied to assign a grid cell to a protected area. On the other hand, the percentage of distribution area present in the network of our target species was in the same range of values found by Rubio-Salcedo & al. (2013) for lichens. Determining whether the actual coverage of endangered and endemic CWR in the Natura 2000 network is acceptable depends on which thresholds are set as a reference base. Thus, if the threshold is the species representation in the network by at least one population, the assessment is favourable, as that reported by Araújo & al. (2007). When the criteria is based on having in the network a higher number of populations, e.g., five (Brown & Briggs, 1991), or a substantial representation of its populations, e.g. 35% (Whitlock & al., 2016), the percentage of targeted CWR species that comply with these requirements is much lower and the appropriateness of the Natura 2000 network for their passive in situ conservation becomes arguable.

Concerning the choice of the optimal threshold to assess the conservation status of endangered endemic CWR in Spain, it is clear that the drafting of conservation measures should not stop with the simple representation of targeted CWR species in protected areas networks or in germplasm banks. Following this approach, it is likely that the genetic diversity component of threatened species will be neglected, being this especially serious in the case of CWR. Attempts to incorporate this component to conservation efforts have been made over the last decades (Brown & Briggs, 1991; Hamilton, 1994; Whitlock & al., 2016) and recently implemented in CWR conservation through the use of ecogeographical land characterization maps as a proxy to estimate genetic diversity (Maxted & al., 2012; Parra-Quijano & al., 2012; Phillips & al., 2016; Taylor & al., 2017). Thus, the problem of assessing the conservation status of the genetic diversity of a species could be approached by following Whitlock et al. (2016) and including 35% of known populations or proportionally representing populations from each of the ecogeographical units where the species is found (Parra-Quijano & al., 2012).

The high percentage of target CWR species found in national and international germplasm collections (81%) highlights the concern of Spanish conservationists in preserving threatened and endemic flora, and the high activity of seed collecting that has taken place by the REDBAG network in order to ex situ preserve at least 60% of Spanish threatened plant species (REDBAG) as targeted by the Global Strategy for Plant Conservation. The latest update of the objectives of the Global Strategy for Plant Conservation raises to 75% the percentage of threatened species to be ex situ preserved (UN CBD, 2010), a goal which is still met for the targeted CWR species. In any case, the nine target CWR species without representation in germplasm banks should be a priority for ex situ collecting missions.

In order to assess whether the genetic diversity component of the target species is being conserved, it is essential to gather information including the number of accessions of each species preserved in germplasm collections. Their origin and collection dates are also important data that should be retrieved. All this information would allow a more precise assessment of the ex situ conservation status of the species and the design of collecting actions to improve the quality of germplasm collections holdings. Garcia & al. (2017) provide an example of this approach. In this study, they identified 88 Spanish CWR species from legumes and cereals crops and assessed their ex situ conservation status, proposing an optimized harvesting design for their collection.

Conclusions

To integrate these species into the national conservation programmes, we suggest an expert conservation assessment for the 11 species that are Critically Endangered and Endangered according to the IUCN criteria but not included in the National Catalogue of Threatened Species of Spain. The case of Sideritis reverchonii Willk., which is not included in any regional catalogue either, should be immediately addressed. These particular assessments would require gathering detailed information on field occurrences, exact number of accessions and their origin in germplasm collections and an ecogeographical evaluation. Authorities in Spain should be informed of results from these assessments and encouraged to design and implement the corresponding conservation plans.

The threatened and endemic CWR of Spain are adequately represented at the species level both in situ, in the Natura 2000 network, and ex situ, by national and international genebanks. However, the in situ conservation of their genetic diversity by the Natura 2000 network is deficient, while additional information is needed to be able to make the assessment at the ex situ level.

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Websites


