IUCN Red List assessment of the Cape Verde endemic flora: towards a Global Strategy for Plant Conservation in Macaronesia

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ABSTRACT

Despite endemism richness on islands underlines the outstanding importance of these enclaves for global conservation, there is no up-to-date synthesis of the conservation status of the Macaronesian Islands vascular flora, which belongs to one of the world's hotspot regions. In this study, we review the conservation status and threats to the endemic vascular flora on the Cape Verde Islands, mostly based on the past two decades of collecting, published literature and herbarium specimens. The application of IUCN Red List criteria and categories using the RAMAS software reveals that 78% of Cape Verde's endemic plants are threatened (29.3% Critically Endangered, 41.3% Endangered, 7.6% Vulnerable). Most of these endemics feature a limited geographic range, and half of them have Area of Occupancy and Extent of Occurrence of less than 20 km^2 and 200 km^2, respectively. Our data show that, over the last two decades, Cape Verdean vascular plants have become more threatened, and their conservation status has declined, mostly as a consequence of the increase in exotic species, habitat degradation and human disturbance. This paper presents the first comprehensive IUCN Red List data for the plants that are endemic to the Cape Verde Islands, providing an important step towards the recognition and conservation of its threatened endemic flora at both the national and global level. It also fills a glaring knowledge gap, as it represents the first thorough assessment of the conservation status of the entire endemic flora of a Macaronesian archipelago.

ADDITIONAL KEYWORDS: biodiversity hotspot – conservation – oceanic islands – RAMAS Red List – threatened species – vascular flora

INTRODUCTION

The continuing decline of plant diversity is the focus of major concerns for researchers, conservation managers, and policy makers (e.g. Tittensor *et al.,* 2014; Pimm *et al.,* 2014). Initiatives to conserve the world's most threatened diversity have developed over the last decades, and the IUCN Red List of Threatened Species (www.iucnredlist.org) is widely recognized as the most objective and comprehensive approach for evaluating the global conservation status of species, and categorizing them according to their estimated risk of extinction (e.g. Mace *et al.*, 2008; Jetz & Freckleton, 2015; Maes *et al.*, 2015). These Red Lists use quantitative criteria based on population size, rate of decline, and area of distribution to assign species to one of seven categories of relative extinction risk, ranging from 'Extinct' to 'Least Concern' (IUCN Standards and Petitions Subcommittee, 2014).

Assessing the conservation status of endemic plants inhabiting small islands is a key challenge because of their restricted geographic distribution and high vulnerability to threats, mainly due to the loss or alteration of their habitats (Caujapé-Castells *et al.*, 2010). But the applicability of the IUCN Red List criteria to the exceptionally high number of endemic vascular plants on most oceanic archipelagos remains to be fully assessed. Foremost amongst these is the Macaronesian Region (i.e. Azores, Canary, Madeira, and Cape Verde Islands), that harbors ca. 900 endemic plant species (Bramwell & Caujapé-Castells, 2011). Indeed, the Macaronesian vascular flora is one of the richest within the Mediterranean biodiversity hotspot (Myers *et al.*, 2000).

The Macaronesian Region hosts over a quarter of the plant species listed in Annex II of the Habitats Directive (Sundseth, 2009), despite representing only 0.2% of the European Union (EU) territory (except the Cape Verde, a non-EU country). Some of these endemics have already been assessed, either in the context of national red lists (i.e. the

Canary Islands, Bañares *et al.*, 2004; Moreno-Saiz, 2008; Moreno-Saiz *et al.*, 2015), or in the European Red List of Vascular Plants (Bilz *et al.*, 2011). However, these reviews only cover some of the endemics from the Macaronesian archipelagos that belong to the EU: the Azores and Madeira (Portugal), and the Canaries (Spain). In spite of the utter rigor of these assessments, a comprehensive Red List for the Macaronesian Region is still lacking, which has major implications for the conservation of biodiversity in this hotspot area.

Cape Verde is the only Macaronesian archipelago located in the tropics. Notwithstanding the scientific value of its biota and the existing conservation concerns, Cape Verde's biodiversity remains poorly understood. The Flora of the Cape Verde Islands (Paiva *et al.*, 1995-1996; Martins *et al.,* 2002) has been an ongoing project for twenty years, and it has still not been completed (e.g. major plant families like Asteraceae, Cyperaceae, Fabaceae, Malvaceae, and Poaceae, still lack a comprehensive treatment). Similarly, the preliminary Red List for the archipelago's flora was published 19 years ago (Leyens & Lobin, 1996), but new endemic taxa have been described or taxonomically rearranged for the archipelago over the last two decades (e.g. Marrero, 2008; Kilian *et al.*, 2010; Romeiras *et al.*, 2011a; Marrero & Almeida, 2012; Knapp & Vorontsova, 2013). Thus, a comprehensive, updated analysis of the available information regarding population size, distribution, and threats to each endemic species is urgently required for the conservation of the region's unique flora.

In this investigation, we assess the conservation status of all vascular endemic plants from the Cape Verde Islands, and we identify the major factors of threat, suggesting conservation measures to be implemented in this archipelago to further contribute to a global conservation strategy for the Macaronesian floras.

MATERIAL AND METHODS

STUDY AREA

The Cape Verde archipelago encompasses the southernmost islands of Macaronesia, and is located 1500 km southwest of the Canary Islands and ca. 570 km west of the African mainland. This archipelago has ten islands distributed in three groups: Santo Antão, São Vicente, Santa Luzia and São Nicolau in the north; Santiago, Fogo, and Brava in the south; and Sal, Boavista and Maio (the islands with the lowest altitudes) in the east (Duarte & Romeiras, 2009). The climate of this archipelago is tropical dry, and altitudinal gradients, together with the effects of north-east trade winds, are key factors in shaping species distribution (Duarte *et al.,* 2008). The vascular plant flora of the Cape Verde archipelago is currently thought to comprise about 740 taxa, 92 of them endemics (Romeiras *et al.*, 2015).

INVENTORY OF THREATENED PLANTS

The data on the vascular plants from Cape Verde's flora have been gleaned mostly from the collections compiled in Portugal in the second half of the 19th century, which are housed at the LISC herbarium (Instituto de Investigação Científica Tropical), as well as from specimens collected by the authors of this paper over the last two decades. Additional data were obtained from bibliographic references, namely the Flora of the Cape Verde Islands (Paiva *et al.*, 1995-1996; Martins *et al.,* 2002), and other publications focusing on endemic plants (e.g. Lobin, 1986; Gomes *et al.*, 1995; Brochmann *et al.*, 1997; Gonçalves, 1999; Duarte *et al.,* 2002; Marrero, 2008; Marrero & Almeida, 2012; Knapp & Vorontsova, 2013). Data bearing on species ecology and distribution in the islands, as well as altitudes, collector's names and dates of collection were included in a database that contains ca. 4700 individual records; whenever possible, the geographical coordinates of the accessions were also considered (only specimens collected after 1955 could be georeferenced, due to insufficient location information provided on historical specimen labels). A total of 4583 specimens were georeferenced using 1:25,000 and 1:100,000 cartographic maps, and the data were compiled in ArcGIS Arcinfo ver. 10.0 (ESRI, 2011).

RED LIST ASSESSMENTS

The conservation status of the Cape Verde endemic flora was evaluated following the IUCN Red List categories, so that each listed species could be classified as Extinct (EX), threatened [i.e. Critically Endangered (CR); Endangered (EN); or Vulnerable (VU)], Near Threatened (NT), Least Concern (LC), or within a Data Deficient (DD) category for species that are very poorly known. From the five quantitative criteria (A–E) which are used to evaluate each taxon (IUCN Standards and Petitions Subcommittee 2014), criterion B (i.e. restricted distribution and decline, fluctuations, and/or fragmentation), and criterion D (i.e. very small or restricted populations) were the most commonly used. The use of criteria A, C and E was avoided due to a lack of information concerning population trends, present and future population decline and probability of extinction, respectively.

We calculated the Area of Occupancy (AOO), Extent of Occurrence (EOO), number of subpopulations, and number of locations for each of the 4583 records of Cape Verdean endemic taxa evaluated. The parameter EOO was estimated using the minimum convex polygon method, which determines the area contained within the shortest continuous imaginary boundary that can be drawn to encompass all the occurrences of a taxon, while AOO was calculated from summing the number of cells occupied by individuals in a grid of 1x1km. For both calculations we used the GeoCAT software (Bachman *et al.*, 2011). Since sampling efforts were not applied with the same intensity to all species and in all places, species may have a greater AOO and EOO than known, causing some uncertainty that may result in distribution underestimates for some taxa. The evaluation of the conservation status was made using the RAMAS Red List software v.2.0 (Akçakaya *et al.*, 2001), which was successfully applied to the Cape Verde IUCN extinction risk assessment of reptiles (Vasconcelos *et al.*, 2013). RAMAS assigns each taxon to Red List Categories according to the IUCN Red List Criteria, and explicitly handles data uncertainty (Akçakaya *et al.*, 2000). Considering the uncertainty that inevitably arises when many of the parameters are unknown, this software package is the most recommended by IUCN authorities and allows us testing different values for the Risk Tolerance (RT). RT ranges from 0 for risk-averse, precautionary; through 0.5 for risk neutral; to 1 for risk prone, evidentiary (Akçakaya *et al.*, 2000). An evidentiary attitude (RT=0.6) was applied, given the above-mentioned sources of uncertainty. Finally, major threats for each taxon were assessed using a standardized list (IUCN Standards and Petitions Subcommittee, 2014) based on information gathered from fieldwork and published data.

RESULTS

STATUS OF THREATENED PLANT SPECIES IN CAPE VERDE

Our results revealed that 78% of the assessed endemics (92 taxa) were listed in threat categories: 27 (29.3%) as CR, 38 (41.3%) as EN, and 7 (7.6%) as VU (Fig. 1). Eight taxa (8.7%) were classified as NT, one (1.1%) as LC, and five (5.4%) as DD (Table 1). Additionally, six taxa (6.5%) belonging to the genus *Lotus* (Fabaceae) were Not

Evaluated (NE), given the wide morphological diversity and considerable taxonomic uncertainties, that hinder the assignment of collected samples to a particular species. Apart from the 92 endemics, two species were classified as Extinct (EX) (*Stachytarpheta fallax* and *Habenaria petromedusa*), as they are known only from the type specimens collected in the 18th century by J.S. Feijó.

Criterion B (geographical range) was the most frequently used for categorization of threat (73.3% taxa). Most of the endemics display a limited geographic range, with half of them having areas of occupancy and extents of occurrence of less than 20 and 200 km^2, respectively. Approximately 27% of the taxa assessed have simultaneously an AOO and an EOO equal to or less than 10 and 100 km^2, respectively; within these, 18 are single-island endemics (SIEs). The largest AOO and/or EOO values (Table 1) are displayed by *Euphorbia tuckeyana*, *Cynanchum daltonii*, *Paronychia illecebroides*, and *Forsskaolea procridifolia*; these species occur in seven or more islands, and most of them were evaluated as NT, save for *Cynanchum daltonii* (LC). The smallest AOO and EOO values were both for *Teline stenopetala* subsp. *santoantaoi* (CR). In CR species, AOO values ranged mainly from 3 to 10.5 km^2 and in VU species from 27 to 56.5 km^2 whereas EOO values were considerably higher, between 3 to 46.8 km^2 in CR species and between 328.3 to 575.8 km^2 in VU species (Fig. 2).

The distribution of threatened species (Fig. 1) shows that the northern and southern mountain island groups present the highest percentage values (ranging from 71% in São Vicente to 79.2% in Brava), because both island groups harbor most of the SIEs, which present restricted AOO and EOO, thus potentially qualifying in the highest threat categories (i.e. CR) under IUCN criterion B (see Table 1). Most of the species distributed in the Eastern Islands have a large EOO, because they are by and large widespread in the archipelago. Nonetheless, these results correspond to global assessments in the archipelago, and the category of particular species for each island may be different, depending on the number of populations and the number and intensity of threats that may affect their survival.

RED LIST CHANGES IN THE LAST TWO DECADES

A comparison between the current conservation assessment of the endemic taxa and the one carried out in 1996 (Table 1, Fig. 3) shows that, overall, the Cape Verdean plants are more threatened and their conservation status has declined over the last two decades. Although about one quarter of the endemic vascular flora was not evaluated by Leyens & Lobin (1996), it is noted that the three taxa previous classified as CR (*Conyza schlechtendalii, Carex antoniensis* and *C. paniculata* subsp. *hansenii*) still remain in this threat category. Recent field surveys have revealed that *C. schlechtendalii* is restricted to a small population in São Nicolau, and the two *Carex* are only found in very small populations in Santo Antão (Ribeira do Paul). Moreover, the categories 'Undetermined' and 'Rare' applied by Leyens & Lobin (1996) are no longer considered by the IUCN (for further details see information in Fig. 3), and almost all the taxa under these categories were now classified as CR or as EN due to the small fragmented and restricted populations. On the other hand, of the 15 taxa assessed as VU in 1996, only *Euphorbia tuckeyana* was downlisted from VU to NT due to its widespread distribution in the archipelago, and to the fact that some populations with a significant number of individuals were recently found in Santo Antão (namely in Tope Coroa).

Despite our results point to an increase in extinction risk during the last two decades, recent field surveys allowed us to rediscover several species reported as extinct by Leyens & Lobin (1996). A first example is *Diplotaxis glauca*, only recorded in Boavista in 1851 (leg. Schmidt; type collection), and considered extinct by Brochmann *et al.,*

(1997) until it was collected in 2013 by one of us (MCD). Also during recent fieldwork, scattered trees of *Dracaena draco* subsp. *caboverdeana* were found in Santiago and Brava, thus supporting the contention by Marrero & Almeida (2012) that currently this species only has natural populations in Santo Antão, São Nicolau and Fogo, growing sub-spontaneously also in Santiago and Brava. Finally, Marrero & Pérez (2013) reported the re-discovery in Brava of the native species *Eulophia guineensis* Lindl. (Orchidaceae).

MAIN THREATS

Following the IUCN Threats Classification Scheme (Version 3.2), the most pervasive threats reported in Cape Verde were, by decreasing order of importance (Fig. 4): i) gathering plants for intentional use; ii) invasive alien species; and iii) nomadic grazing. Natural disasters, specifically recent volcanic events (with the most recent eruption occurring in 2014) have an impact on species that occur above 1600 m a.s.l. on Fogo Island, whereas tourism and recreation areas are especially significant for the taxa distributed in lowland coastal areas. Most of the threats were recorded between 400 and 1200 m a.s.l. and were especially associated with strong anthropic disturbances, namely nomadic grazing, gathering endemic plants for intentional use, and invasive species (Fig. 4).

DISCUSSION

Our study presents the most comprehensive Red Data List for the endemic vascular plants of the Cape Verde Islands, providing an important step towards the recognition and conservation of the threatened flora of this archipelago at both national and global level. Internationally, the conservation of endemic Cape Verde flora is of great importance; according to a recent review by Caujapé-Castells *et al.* (2010), its flora is one of the most threatened in the Macaronesian archipelagos. Our results, pointing to 78% of threatened taxa, unequivocally confirm the uppermost position followed by Azores, Madeira and the Canary Islands with 63%, 49% and 30% of threatened taxa, respectively (Caujapé-Castells *et al.*, 2010).

A high extinction risk was recently documented in the Red List of the endemic monocotyledons from Morocco (Rankou *et al.*, 2015), which is a West African country mainly characterized by a semi-arid climate, like the Cape Verde Islands. In both cases 70% of the assessed endemic flora was classified in high-risk categories (CR or EN). Therefore, the higher vulnerability of the Cape Verde endemic flora could be mainly explained by its tropical dry climate and by the increasing aridity that affects the islands, especially at lower altitudes, which could have led to population reductions and restrictions on distribution ranges of the taxa.

Nevertheless, the high proportion of threatened species revealed in our study might be also influenced by some drawbacks during the conservation assessments, mostly because the sampling efforts were not uniformly distributed in all Cape Verde regions/islands, and species may have greater areas than recognized. Thus, the inadequacies in taxonomic and distributional data, the so-called Linnean and Wallacean shortfalls (Whittaker *et al.*, 2005), which are recognized to increase in more remote areas such as oceanic islands (Ladle & Whittaker, 2011), constitute two of the most pressing problems for the thorough conservation of the Cape Verde flora. To reduce the referred shortfalls, it is essential to study different biodiversity units, which can range from genes to landscapes. Therefore, the conservation of intraspecific genetic diversity at archipelago scale, together with the protection of species and habitats, will be of particular importance to underpin conservation programmes. Recently, studies focusing on the Macaronesian flora (García-Verdugo *et al.*, 2015; Patiño *et al.*, 2015; Romeiras *et al.,* 2015) revealed that some plant lineages are genetically more diverse than previously recognized. These findings further highlight the need to conserve insular populations, as many of them are not as "genetically depauperated" as previously thought (García-Verdugo *et al.*, 2015). Nevertheless, the concrete application of genetic data to the design of protected areas at the archipelago scale remains largely unexplored in insular biodiversity hotspots (Buerki *et al.*, 2015).

The present global assessment of the conservation status of Cape Verdean endemic vascular plants shows that more than three-quarters of species are classified in one of the threat categories (i.e. CR, EN, and VU) under IUCN Red List standards. A further five species are listed as DD, and it is extremely likely that these endemic taxa are threatened. Nevertheless, and as suggested in these situations (Akçakaya *et al.*, 2000), our recommendation is that Cape Verdean DD species should be assigned the same degree of protection as threatened species until more information is available. Such scenario would add new species to the threat categories, and have consequences for conservation prioritization. Additionally, our results illustrate the importance of an accurate taxonomy prior to a conservation assessment in insular endemic plants, thus reinforcing Mace's (2004) opinion that more collaboration is needed among conservation biologists and high-profile taxonomists. This was particularly relevant regarding the genus *Lotus*, which was not evaluated due to the wide morphological diversity that hinders the clear taxonomic delimitation of the species.

The IUCN Red List system has been refined over the 20 years since the first Cape Verdean plant Red List was published; given the significant differences in assessment methodologies it seems in order to compare with the previous list. Although our data point towards an increase in extinction risk during the last two decades, this result might be also related to: i) the use of new more accurate data, which generate more realistic assessments; ii) the application of IUCN available tools (e.g. the RAMAS software) instead of 'expert opinion'; iii) the inclusion of new analyses on the threats impacting the Cape Verdean plants; iv) the enlargement of the assessment to all the endemic flora, with a considerable number of taxa being categorized for the first time and being assigned to thread categories; and v) changes in the taxonomy of some groups that produced an upward surge of critically endangered species due to taxonomic splitting. This may have considerable conservation implications since some clades were divided (e.g. *Echium stenosiphon* s.l., see Romeiras *et al.*, 2011a), with the new taxa presenting more restricted AOO and EOO.

The high percentage of threatened taxa in Cape Verde is alarming and, as in other insular ecosystems (e.g. Caujapé-Castells *et al.*, 2010; Kueffer *et al.*, 2010), habitat degradation, human disturbance (e.g. intentional use for agriculture or traditional uses; Romeiras *et al.*, 2011b) and introduction of exotic species since the beginning of islands colonization (Romeiras *et al.,* 2014) are among the main threats. Furthermore, the recent volcanic activity on Fogo Island could lead to population extinctions, particularly among the single-island endemics (SIEs: *Echium vulcanorum*, *Erysimum caboverdeanum* and *Verbascum cystolithicum*) that mainly occur above 1600 m in Chã das Caldeiras.

In general, these threats have a great negative impact in the Cape Verde flora: most endemics display a limited geographic range (both in terms of AOO and EOO), thus being more susceptible to extinction. To prevent taxa from going extinct, several conservation actions were undertook in the last years by the Cape Verde authorities, namely establishing a system of Protected Areas (PA) to safeguard the archipelago's natural heritage (MAAP, 2004). Presently, the National PA network encompasses 47 different regions, totalizing 63,067 ha of land area (see http://www.areasprotegidas.gov.cv) that include four main protection categories: Nature Reserve, Natural Park, Natural Monument, and Protected Landscape. Among these, the Natural Parks encompass sensitive areas for biodiversity conservation, where the majority of the endemic plants occur (e.g. Tope de Coroa – Santo Antão; Monte Gordo – São Nicolau; Monte Verde – São Vicente; Serra da Malagueta – Santiago; Chã das Caldeiras - Fogo). These National Parks are found in mountain regions of the northern and southern island groups, where most of the endemics occur as small and isolated populations, mostly in the northeast-exposed slopes above 400 m. In these mountain areas, greater floristic affinities are shared with the other Macaronesian archipelagos, especially with the Canaries and Madeira. Among these affinities we find several endemics that belong to some of the biggest plant radiations in Macaronesia and worldwide (e.g. *Aeonium*; *Echium*; *Euphorbia*; *Micromeria*; *Sonchus*; *Tolpis*), thus posing a compelling need to conserve the whole extent of their natural ranges as a key objective to the informed conservation of the Macaronesian biodiversity.

On the other hand, the eastern islands (i.e. Sal, Boavista, and Maio) are lower in altitude, they undergo long periods of severe drought, and they have poor vegetation contents, with fewer endemics for which urgent conservation actions are also needed. However, the implementation of the PA was focused mainly on marine resources or fauna species, like see birds or turtles (Mauremootoo, 2012). Threats to the endemic plant species are mainly driven by habitat loss and anthropogenic disturbance, in particular related with touristic infrastructures and urban development. Especially on the coastal sands and dunes of Sal and Boavista, tourism growth has caused dramatic habitat changes, with already noticeable negative impacts on the endemic flora (for instance, in the surrounding areas of Praia de Santa Maria on Sal Island, where a very small population of *Pulicaria burchardii* subsp. *longifolia* is undergoing fast decline).

The information in this study should be used to provide guidance for future management and conservation efforts to ensure a survival of these threatened species in these islands. However, because designating new PA will be a complex task (i.e. there are several competing land-use options and considerable socio-economic costs associated with PA implementation), a species prioritization procedure is mandatory.

FINAL REMARKS

Internationally, the four Macaronesian archipelagos ratified through their respective countries the Convention on Biological Diversity, and are included in the Mediterranean “Biodiversity Hotspot”, which implies that concerted actions aimed at preserving the profuse biodiversity of the Macaronesian region should be taken. At the regional level, policy frameworks have been implemented to guide biodiversity conservation in the Cape Verde Islands (National PAs network), and it is urgent to develop new field surveys to fill glaring gaps in species distribution data, and to monitor population sizes, their sensitivity to disturbances, and other threats that may affect them. Recent inventories allowed the rediscovery in some islands of species reported extinct, thus further underscoring the importance of increased field collection efforts. Intensifying prospection, especially in the hardly accessible mountain areas, would probably increase the number of records of both old-described and undercollected species, while refining the knowledge of their distribution ranges.

Conservation projects are time-sensitive, and research funding opportunities in developing countries like Cape Verde are becoming increasingly restricted, but our ability to embrace informed, integrative approaches to biodiversity science is always contingent on the availability of scientifically sound data. This Red List provides a first comprehensive framework for identifying and prioritizing threatened species, thus constituting a crucial step towards a better strategy to conserve the endemic flora in the southernmost archipelago of Macaronesia.

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FIGURE LEGENDS

Figure 1. Distribution of Cape Verde endemic species by threatened categories [Critically Endangered (CR); Endangered (EN); Vulnerable (VU)] in the archipelago (left) and in each island (right). Island abbreviations: Santo Antão (ANT); São Vicente (VIC); Santa Luzia (LUZ); São Nicolau (NIC) (Northern Group); Sal (SAL); Boavista (BOA); Maio (MAI) (Eastern Group); Santiago (SAN); Fogo (FOG); Brava (BRA) (Southern Group).

Figure 2. Species geographic range - AOO (area of occupancy) and EOO (extent of occurrence) - for the 72 endemic species classified under threatened categories [Critically Endangered (CR); Endangered (EN); Vulnerable (VU)].

Figure 3. Status change in IUCN Red List of the Cape Verdean endemic flora from 1996 (Leyens & Lobin previous inventory) to 2015 (present assessment). Species classified in 1996 as Undetermined (applied when it was not possible to accurately classify a species into any of the threatened categories CR, EN or VU) or Rare (species restricted to isolated populations, and to which there was not enough information to determine their conservation status, but corresponding most likely to CR, EN or VU) were considered here as Threatened.

Figure 4. Incidence along elevation classes of the main threats to the Cape Verdean endemic plants. Dimension of circles proportional to the number of species affected in the corresponding elevation class. Classification of threats as defined by IUCN. (http://www.iucnredlist.org/technical-documents/classification-schemes/threats-classification-scheme)

TABLE:

Table 1. Some parameters used for the assessment of conservation status of the Cape Verde endemic plant taxa, and Red List categories and criteria.

Family	Taxon	Islands*	AOO (km^2)	EOO (km^2)	Red List 1996**	Red List 2015	Criteria 2015
Crassulaceae	*Aeonium gorgoneum* J. A. Schmidt	3	38	224,26	LR	EN	B1ab(ii,iii)+2ab(ii,iii)
Poaceae	*Aristida cardosoi* Cout.	10(9)	53	848,37	NE	NT	
Asteraceae	*Artemisia gorgonum* Webb	3	37	260,40	VU	VU	B1ab(ii,iv)+2ab(ii,iv)
Asparagaceae	*Asparagus squarrosus* J. A. Schmidt	7	50	924,03	LR	NT	
Asteraceae	*Asteriscus daltonii* (Webb) Walp. subsp. *daltonii*	1	11	66,73	EN	EN	D
Asteraceae	*Asteriscus daltonii* subsp. *vogelii* (Webb) Greuter	7	91	1151,37	LR	NT	
Asteraceae	*Asteriscus smithii* (Webb) Walp.	1	4	4,00	EN	CR	B1ab(iii)+2ab(iii)
Poaceae	*Brachiaria lata* (Schumach.) C. E. Hubb. subsp. *caboverdeana* Conert & Ch. Köhler	4	41	569,44	VU	VU	B1ab(iii)+2ab(iii)
Campanulaceae	*Campanula bravensis* (Bolle) A. Chev.	3	44	224,99	LR	EN	B1ab(ii,iv)+2ab(ii,iv)
Campanulaceae	*Campanula jacobaea* C. Sm. ex Webb	4	74	514,36	NE	VU	B1ab(ii)+2ab(ii)
Plantaginaceae	*Campylanthus glaber* Benth. subsp. *glaber*	6	66	1001,20	VU	EN	B1ab(ii)+2ab(ii)
Plantaginaceae	*Campylanthus glaber* Benth. subsp. *spathulatus* (A. Chev.) Brochmann, N. Kilian, Lobin & Rustan	1	11	143,13	NE	EN	B1ab(ii)+2ab(ii); D
Cyperaceae	*Carex antoniensis* A. Chev.	1	3	3,00	CR	CR	B1ab(ii)+2ab(ii); D
Cyperaceae	*Carex paniculata* L. subsp. *hansenii* Lewej. & Lobin	1	3	3,00	CR	CR	B1ab(ii)+2ab(ii); D
Gentianaceae	*Centaurium tenuiflorum* (Hoffmanns. & Link) Fritsch subsp. *viridense* (Bolle) A. Hansen & Sunding	3	11	207,63	NE	CR	D

Asteraceae	*Conyza feae* (Bég.) Wild	6(5)	76	617,39	EN	EN	B1ab(ii,iv)+2ab(ii,iv)
Asteraceae	*Conyza pannosa* Webb	5	22	166,08	EN	EN	B1ab(ii,iv)+2ab(ii,iv)
Asteraceae	*Conyza schlechtendalii* Bolle	1	3	3,00	CR	CR	D
Asteraceae	*Conyza varia* (Webb) Wild	5	45	258,96	EN	EN	B1ab(ii,iv)+2ab(ii,iv)
Asclepiadaceae	*Cynanchum daltonii* (Decne. ex Webb) Liede & Meve	7	105	1534,62	NE	LC	None
Brassicaceae	*Diplotaxis antoniensis* Rustan	1	16	187,84	NE	VU	D1+2
Brassicaceae	*Diplotaxis glauca* J. A. Schmidt	2	10	103,56	VU	CR	D
Brassicaceae	*Diplotaxis gorgadensis* Rustan subsp. *brochmannii* Rustan	1	3	3,00	VU	CR	B1ab(ii)+2ab(ii)
Brassicaceae	*Diplotaxis gorgadensis* Rustan subsp. *gorgadensis*	1	12	171,77	NE	EN	B1ab(ii)+2ab(ii)
Brassicaceae	*Diplotaxis gracilis* (Webb) O. E. Schulz	1	10	146,12	VU	EN	B1ab(iii)+2ab(iii)
Brassicaceae	*Diplotaxis hirta* (A. Chev.) Rustan & Borgen	1	25	212,58	NE	EN	B1ab(ii)+2ab(ii)
Brassicaceae	*Diplotaxis sundingii* Rustan	1	3	3,00	R	CR	B1ab(ii)+2ab(ii)
Brassicaceae	*Diplotaxis varia* Rustan	2	25	214,53	I	EN	B1ab(ii)+2ab(ii)
Brassicaceae	*Diplotaxis vogelli* (Webb) Cout.	1	6	43,61	I	CR	B1ab(ii)+2ab(ii)
Asparagaceae	*Dracaena draco* (L.) L. subsp. *caboverdeana* Marrero Rodr. & R. Almeida	6(3)	16	53,00	NE	CR	B1ab(ii,iv)
Dryopteridaceae	*Dryopteris gorgonea* J.P. Roux	3	3	3,00	NE	DD	
Boraginaceae	*Echium hypertropicum* Webb	2	34	222,65	EN	EN	B1ab(ii)+2ab(ii)
Boraginaceae	*Echium stenosiphon* Webb subsp. *glabrescens* (Pett.) Romeiras & Maria C. Duarte	1	29	105,60	LR	EN	B1ab(ii)+2ab(ii)
Boraginaceae	*Echium stenosiphon* Webb subsp. *lindbergii* (Pett.) Bramwell	1	42	284,83	I	EN	B1ab(ii)+2ab(ii)
Boraginaceae	*Echium stenosiphon* Webb subsp. *stenosiphon*	1	14	59,48	VU	CR	B1ab(ii)
Boraginaceae	*Echium vulcanorum* A. Chev.	1	21	121,75	EN	EN	B1ab(ii)+2ab(ii)
Poaceae	*Eragrostis conerti* Lobin	5	14	71,60	R	DD	
Brassicaceae	*Erysimum caboverdeanum* (A. Chev.) Sund.	1	13	50,03	EN	CR	B1ab(ii)
Euphorbiaceae	*Euphorbia tuckeyana* Steud. ex Webb	9(8)	108	1145,26	VU	NT	
Zygophyllaceae	*Fagonia mayana* Schlecht.	3	11	91,91	NE	DD	
Urticaceae	*Forsskaolea procridifolia* Webb	9	93	1569,67	NE	NT	
Frankeniaceae	*Frankenia ericifolia* Chr. Sm. ex DC. subsp. *caboverdeana* Brochmann, Lobin & Sunding	3	20	590,48	NE	EN	B1ab(ii)+2ab(ii)
Frankeniaceae	*Frankenia ericifolia* Chr. Sm. ex DC. subsp. *montana* Brochmann, Lobin & Sunding	1	6	8,19	EN	CR	B1ab(iii)+2ab(iii)
Plantaginaceae	*Globularia amygdalifolia* Webb	5	50	378,28	VU	EN	B1ab(ii)+2ab(ii)
Orchidaceae	*Habenaria petromedusa* Webb				NE	EX	

Cistaceae	*Helianthemum gorgoneum* Webb	4	43	490,61	NE	EN	B1ab(ii,iv)+2ab(ii,iv)
Asteraceae	*Helichrysum nicolai* N. Kilian, Galbany & Oberpr.	1	2	2,00	NE	CR	D
Plantaginaceae	*Kickxia elegans* (G. Forst.) D. A. Sutton subsp. *dichondrifolia* (Benth.) Rustan & Brochmann	4	24	290,46	NE	EN	B1ab(ii,iv)+2ab(ii,iv)
Plantaginaceae	*Kickxia elegans* (G. Forst.) D. A. Sutton subsp. *elegans*	9(8)	56	902,06	NE	EN	B1ab(iv)+2ab(iv)
Plantaginaceae	*Kickxia elegans* (G. Forst.) D. A. Sutton subsp. *webbiana* (Sunding) Rustan & Brochmann	1	14	132,63	NE	EN	B1ab(ii)+2ab(ii)
Asteraceae	*Launaea gorgadensis* (Bolle) N. Kilian	3	15	26,29	LR	CR	B1ab(iii)
Asteraceae	*Launaea picridioides* (Webb) Engler	3	56	667,82	LR	VU	B1ab(ii)+2ab(ii)
Asteraceae	*Launaea thalassica* N. Kilian, Brochmann & Rustan	1	9	18,36	R	CR	B1ab(iii)+2ab(iii)
Lamiaceae	*Lavandula rotundifolia* Benth.	5	95	1060,16	LR	NT	
Plumbaginaceae	*Limonium braunii* (Bolle) A. Chev.	4	24	244,98	NE	EN	B1ab(ii)+2ab(ii)
Plumbaginaceae	*Limonium brunneri* (Webb) Kuntze	3	13	59,06	LR	CR	B1ab(ii,iii,iv)
Plumbaginaceae	*Limonium jovi-barba* (Webb) Kuntze	2	10	15,58	R	CR	B1ab(ii); D
Plumbaginaceae	*Limonium lobinii* N. Kilian & T. Leyens	1	10	13,58	R	CR	B1ab(ii); D
Plumbaginaceae	*Limonium sundingii* Leyens, Lobin, N. Kilian & Erben	1	2	2,00	R	CR	D
Brassicaceae	*Lobularia canariensis* (DC.) Borgen subsp. *fruticosa* (Webb) Borgen	5	33	192,69	I	EN	B1ab(ii,iv)+2ab(ii,iv)
Brassicaceae	*Lobularia canariensis* (DC.) Borgen subsp. *spathulata* (J. A. Schmidt) Borgen	2	11	26,29	I	CR	B1ab(iii)
Fabaceae	*Lotus alianus* J.H. Kirkbr.	2	1	1,00	NE	NE	
Fabaceae	*Lotus arborescens* Lowe ex Cout.	1	4	4,00	R	NE	
Fabaceae	*Lotus brunneri* Webb	5	33	354,46	LR	NE	
Fabaceae	*Lotus jacobaeus* L.	2	26	305,68	NE	NE	
Fabaceae	*Lotus latifolius* Brand	1	24	283,06	NE	NE	
Fabaceae	*Lotus purpureus* Webb	7	58	514,75	NE	NE	
Lamiaceae	*Micromeria forbesii* Benth.	5	52	366,77	I	EN	B1ab(ii,iv)+2ab(ii,iv)
Papaveraceae	*Papaver gorgoneum* Cout. subsp. *gorgoneum*	2	8	39,96	VU	CR	B1ab(ii)+2ab(ii)
Papaveraceae	*Papaver gorgoneum* Cout. subsp. *theresias* Kadereit & Lobin	1	5	14,73	NE	CR	B1ab(ii)+2ab(ii); D
Caryophyllaceae	*Paronychia illecebroides* Webb	8(7)	103	1518,93	LR	NT	
Apocynaceae	*Periploca chevalieri* Browicz	6	61	553,66	EN	EN	B1ab(ii)+2ab(ii)
Asteraceae	*Phagnalon melanoleucum* Webb	5	46	255,60	NE	EN	B1ab(ii)+2ab(ii)
Arecaceae	*Phoenix atlantica* A. Chev.	4	17	317,03	NE	EN	B1ab(iii)+2ab(iii)
Caryophyllaceae	*Polycarpaea gayi* Webb	6	93	920,38	LR	NT	

Asteraceae	*Pulicaria burchardii* Hutch. subsp. *longifolia* Gamal-Eldin	1	2	2,00	NE	DD	
Asteraceae	*Pulicaria diffusa* (Shuttlew. ex Brunn.) Pett.	5(4)	20	344,42	VU	EN	B1ab(iv)+2ab(iv)
Sapotaceae	*Sideroxylon marginata* (Decne.) Cout.	8(5)	24	456,31	EN	EN	B1ab(ii)+2ab(ii)
Solanaceae	*Solanum rigidum* Lam.	7(5)	17	396,29	NE	VU	B1ab(ii)+2ab(ii)
Asteraceae	*Sonchus daltonii* Webb	5	44	261,98	I	EN	B1ab(iv)+2ab(iv)
Poaceae	*Sporobolus minutus* Link subsp. *confertus* (J.A. Schmidt) Lobin, N. Kilian & Leyens	2	4	4,00	R	DD	
Verbenaceae	*Stachytarpheta fallax* A.E. Gonç.				NE	EX	
Fabaceae	*Teline stenopetala* (Webb & Berthel.) Webb & Berthel. subsp. *santoantaoi* Marrero-Rodr.	1	1	1,00	NE	CR	D
Asteraceae	*Tolpis farinulosa* (Webb) Schmidt	5	28	192,45	I	EN	B1ab(ii)+2ab(ii)
Apiaceae	*Tornabenea annua* Bég.	1	28	237,96	VU	EN	B1ab(ii)+2ab(ii)
Apiaceae	*Tornabenea bischoffii* J. A. Schmidt	1	20	402,25	VU	EN	B1ab(ii)+2ab(ii)
Apiaceae	*Tornabenea humilis* Lobin & K. H. Schmidt	1	13	207,73	NE	EN	B1ab(ii)+2ab(ii)
Apiaceae	*Tornabenea insularis* (Parl. ex Webb) Parl. ex Webb	3	22	84,18	LR	EN	D
Apiaceae	*Tornabenea ribeirensis* Schmidt & Lobin	1	5	10,46	NE	CR	B1ab(iii)+2ab(iii)
Apiaceae	*Tornabenea tenuissima* (A. Chev.) A. Hans. & Sunding	1	8	55,94	VU	CR	B1ab(ii)+2ab(ii)
Crassulaceae	*Umbilicus schmidtii* Bolle	4	23	100,43	R	EN	B1ab(ii)+2ab(ii)
Scrophulariaceae	*Verbascum capitis-viridis* Hub.-Mor.	6(3)	57	582,22	VU	VU	B1ab(ii,iii)+2ab(ii,iii)
Scrophulariaceae	*Verbascum cystolithicum* (B. Petterson) Huber-Morath	1	23	158,42	NE	EN	B1ab(ii)+2ab(ii)
Solanaceae	*Withania chevalieri* A.E. Gonç.	4(3)	6	6,00	NE	CR	B1ab(ii)+2ab(ii)

*Number of islands where the species is known. In brackets: islands for which was obtained data, when different from the known distribution.

**Red List categories according to Leyens & Lobin (1996), but criteria were not obtained at that time.

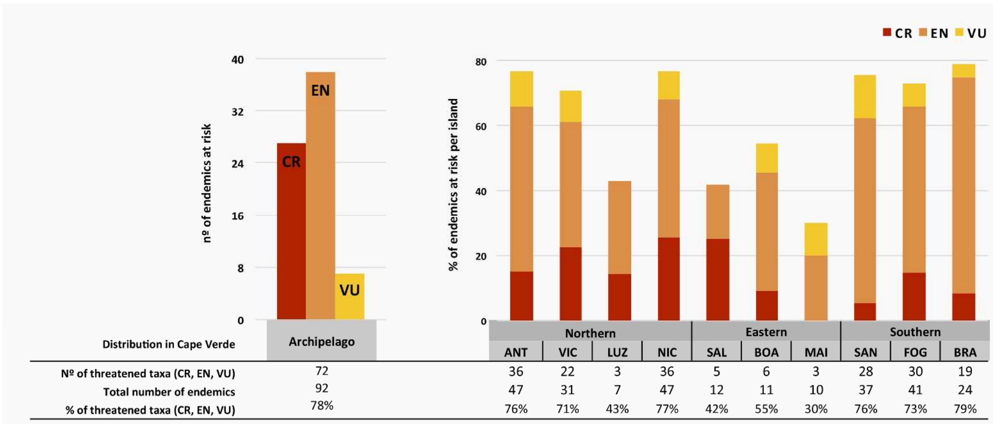

Figure 1. Distribution of Cape Verde endemic species by threatened categories [Critically Endangered (CR); Endangered (EN); Vulnerable (VU)] in the archipelago (left) and in each island (right). Island abbreviations: Santo Antão (ANT); São Vicente (VIC); Santa Luzia (LUZ); São Nicolau (NIC) (Northern Group); Sal (SAL); Boavista (BOA); Maio (MAI) (Eastern Group); Santiago (SAN); Fogo (FOG); Brava (BRA) (Southern Group).
291x124mm (300 x 300 DPI)

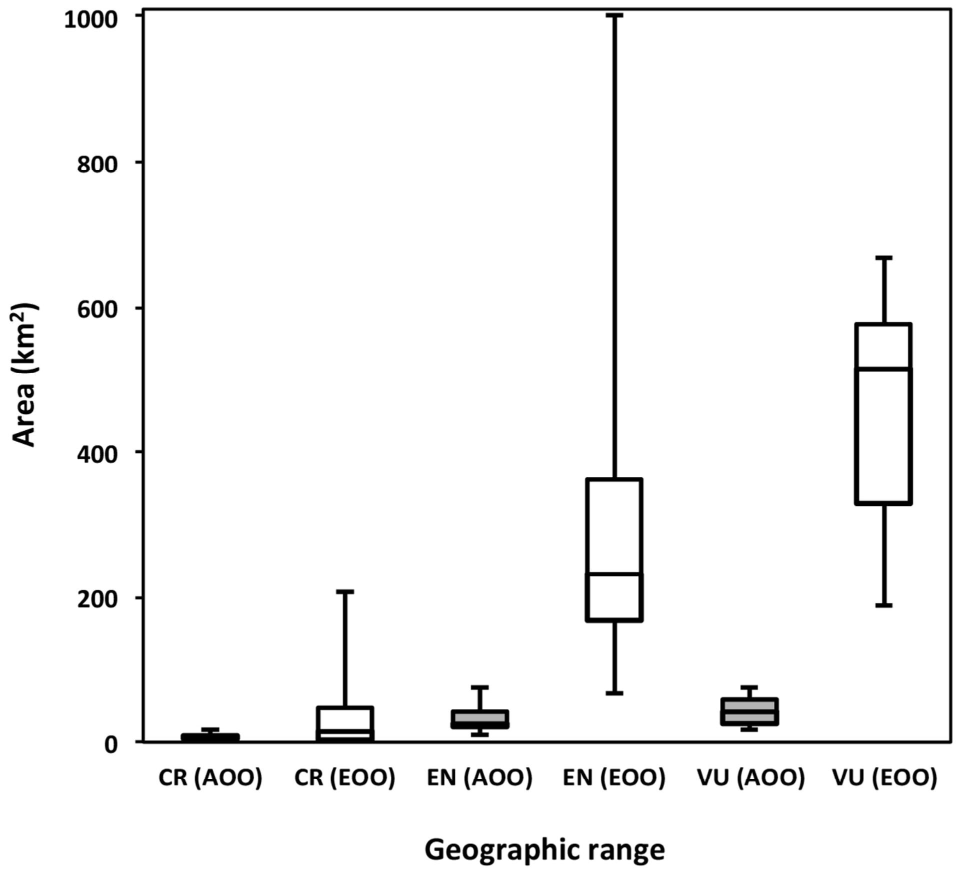

Figure 2. Species geographic range - AOO (area of occupancy) and EOO (extent of occurrence) - for the 72 endemic species classified under threatened categories [Critically Endangered (CR); Endangered (EN); Vulnerable (VU)].
117x107mm (300 x 300 DPI)

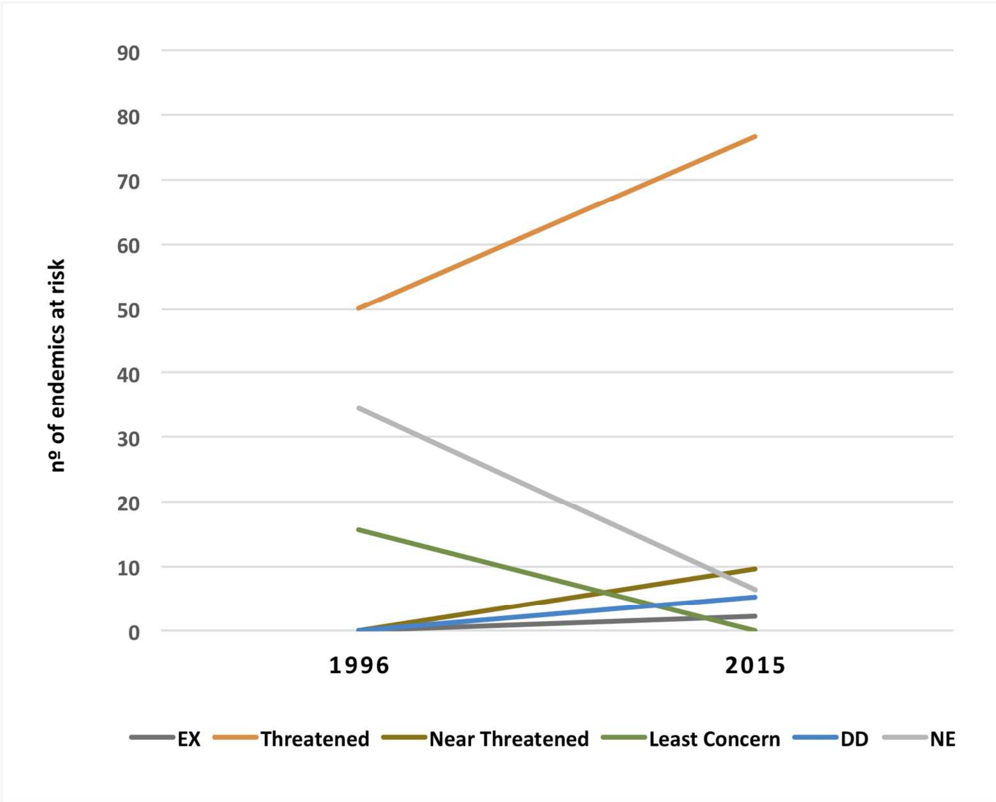

Figure 3. Status change in IUCN Red List of the Cape Verdean endemic flora from 1996 (Leyens & Lobin previous inventory) to 2015 (present assessment). Species classified in 1996 as Undetermined (applied when it was not possible to accurately classify a species into any of the threatened categories CR, EN or VU) or Rare (species restricted to isolated populations, and to which there was not enough information to determine their conservation status, but corresponding most likely to CR, EN or VU) were considered here as Threatened.
162x131mm (300 x 300 DPI)

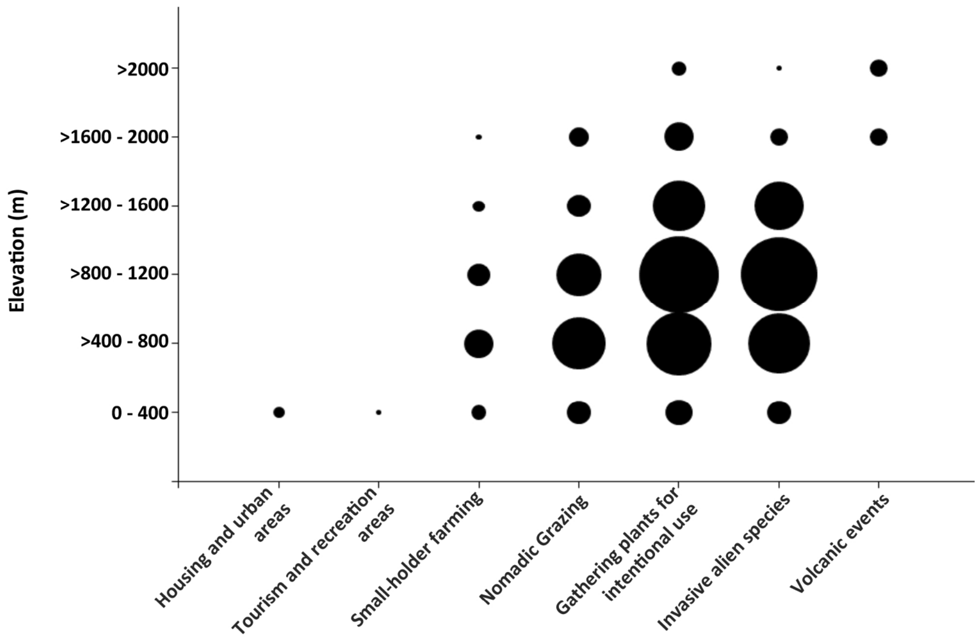

Figure 4. Incidence along elevation classes of the main threats to the Cape Verdean endemic plants. Dimension of circles proportional to the number of species affected in the corresponding elevation class. Classification of threats as defined by IUCN. (http://www.iucnredlist.org/technical-documents/classification-schemes/threats-classification-scheme)
171x118mm (300 x 300 DPI)