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BIODIVERSITY RESEARCH

WILEY Diversity and Distributions

Vascular plant extinctions in California: A critical assessment

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Abstract

Aim: Extinctions of species and subspecific taxa in hotspots of biodiversity deserve special attention. After more than 40 years of major efforts, estimates of extinct plant taxa in California seem to be somewhat stabilized. The time is ripe for an attempt to critically evaluate our current knowledge of plant extinctions in California and make a comparison with other countries with mediterranean-type climates.

Location: California.

Methods: Besides species-specific studies and personal communications, major databases and state floras were consulted.

Results: Compared with all numbers published earlier, the current analysis ended with smaller numbers of globally extinct plant species and taxa (13 and 17, respectively) and larger numbers of species and taxa extinct in California, but still present in at least one other state or country (15 and 15). For each species, life form, habitat, year of the last collection and assumed drivers of extinction are listed.

Main conclusions: Most of the presumed extinct taxa were originally present in one or two counties and often are known from only one or a very few collections. Therefore, the most robust generalization regarding factors contributing to taxon extinctions is a small range size and a low original abundance. Most of the presumed globally extinct taxa were originally present in lowlands where most of the human population and habitat destruction are concentrated. Taxa limited to special habitats, like wetlands, seem to be more predisposed to extinction. Among assumed drivers of plant extinction, agriculture, urbanization and development in general are the most often cited possibilities. Compared with other countries with mediterranean-type climates, the extinction rate of vascular plants in California is lower than in Israel, comparable with the Cape Province of South Africa, Western Australia and continental Mediterranean European countries, and higher than in Chile.

KEYWORDS
California, extinctions, global change, mediterranean-type climates, rarity, vascular plants

1 | INTRODUCTION

The California Floristic Province covering most of California, part of south-western Oregon, part of northern Baja California and a very small area in western Nevada is one of 25 worldwide biodiversity hotspots recognized by Myers, Mittermeier, Mittermeier, da Fonseca, and Kent (2000) or 36 hotspots recognized more recently (Mittermeier, Turner, Larsen, Brooks, & Gascon, 2011; Noss et al., 2015). California contains a higher numbers of native and endemic vascular plant taxa than other state or province in North America north of Mexico. There are 5,280 native vascular plant species (6,530 currently recognized taxa) in California, including 1,311 endemic species (2,267 taxa + 5 hybrids) (Jepson Flora Project, 2016). Our understanding of the factors responsible for this exceptional diversity was recently summarized by Baldwin (2014).

Authors (year/edition)	Extinct globally		Extinct in California		Total	
	Species	Taxa	Species	Taxa	Species	Taxa
Powell (1974/1st)	31	33	11	12	42	45
Smith, Cole, and Sawyer (1980/2nd)	28	33	10	11	38	44
Smith and York (1984/3rd)	24	28	5	6	29	34
Smith and Berg (1988/4th)	24	32	6	7	30	39
Skinner and Pavlik (1994/5th)	23	28	6	6	29	34
Tibor (2001/6th)	20	25	4	4	24	29
CNPS (2017/v8-02)	18	22	7	7	25	29
Current analysis	13	17	15	15	28	32

TABLE 1 Numbers of vascular plant species and taxa reported as presumed extinct in the inventories of rare and endangered vascular plants in California and based on the current analysis

Unfortunately, not all native taxa are surviving in human-modified landscapes. In California, serious attention to local and global plant extinctions has been generated by several editions of the Inventory of Rare and Endangered Plants published by the California Native Plant Society (CNPS; see Table 1). More recent versions have been available online at http://www.rareplants.cnps.org. Over 40 years of the CNPS Inventories, many once presumed extinct taxa have been rediscovered and some new presumed extinct taxa have been added because recent field surveys were not successful. Over the same period, various numbers of extinct plant taxa in California have appeared in general biological literature:

1977: "28 species and 5 additional intraspecific taxa" (Raven, 1977; globally extinct—based on Ayensu, 1975; Powell, 1974; Ripley, 1975).

1994: "28 extinct taxa" (Greuter, 1994; globally extinct—based on Smith & York, 1984).

1998: "34 extinct taxa" (Hobbs & Mooney, 1998; extinct globally and extinct in California—based on Skinner & Pavlik, 1994).

2003: "29 extinct taxa" (Ornduff, Faber, & Keeler-Wolf, 2003; extinct globally and extinct in California—based on Tibor, 2001).

2016: "20 globally extinct species" (Tershy et al., 2016—based on various sources).

Interestingly, only the authors of the last publication tried to provide a summary of extinction drivers (Tershy et al., 2016, table 11.1). Based on their table, proximate drivers of California global plant extinctions were habitat destruction (seven species), invasive species (three species), habitat destruction + invasive species (one species) and unknown drivers (nine species). It is not clear whether "invasive species" included just naturalized plants and animals or all alien organisms, including introduced livestock. Considering many uncertainties and inconsistent reports, the time is ripe for an attempt to summarize and critically evaluate our current knowledge of plant extinctions in California.

2 | METHODS

Besides species-specific studies, three major sources were used for the following analysis: (1) the most recent Inventory of Rare and Endangered Plants published by the CNPS, Rare Plant Program (2017); (2) the electronic version of The Jepson Manual (Baldwin et al., 2012), that is, the Jepson eFlora (http://ucjeps.berkeley,edu/eflora/), searched for "extinct" and "extirpated"; and (3) data provided by the participants of the Consortium of California Herbaria (ucjeps.berkeley.edu/consortium/). The last two sources are the major achievements of the last decade, providing qualitatively higher level of our knowledge of the state flora. Three groups of taxa will be discussed: (1) taxa presumed extinct globally (Table 2); (2) taxa extinct in California, but present in at least one other state (Table 3); and (3) excluded taxa (Table 4).

3 | RESULTS

3.1 | Taxa presumed extinct globally

Taxa presumed extinct globally are listed in Table 2. The resulting numbers (13 species and 17 taxa) are smaller than those in any version of the Inventory of Rare and Endangered Plants compiled by the CNPS and smaller than any numbers in published literature (Table 1). Five extra species that are in this category in the CNPS Inventory (*Castilleja uliginosa*, *Malacothamnus mendocinensis*, *M. parishii*, *Mimulus brandegeei*, *Plagiobothrys glaber*) are currently recognized only as synonyms of other extant species or have been rediscovered recently (Table 4). All taxa remaining in this category are endemic to the California Floristic Province (Burge et al., 2016). Two species were present only on one of the Californian islands (*Lycium verrucosum*—San Nicolas Is., *Mimulus traskiae*—Santa Catalina Is.). At least 14 of the 17 taxa once grew in lowlands (<500 m) and all of them at elevations <900 m. Seven taxa were present in some kind of wetlands. Ten taxa were originally present in only one county or island and five in two counties. Only two taxa were originally more widespread: *Helianthus nutallii* ssp. *parishii* (three counties) and *Cryptantha hooveri* (five counties). Five taxa are known only from the 19th century, 11 from the first half of the last century and one was collected several times in the second half of the last century. The assumed extinction drivers of these taxa are urbanization and development (mentioned six times), agriculture (incl. grazing) (mentioned four times), wetland modification and change of water regime (mentioned three times), human-caused

TABLE 2 Globally extinct taxa (13 species, 17 taxa)

Taxon	Family	Life form	Habitat	Last seen	Extinction driver
Atriplex tularensis Coville	Chenopodiaceae	Annual herb	Alkali sink scrub, 90–140 m	1991[a]	Agriculture, lowered water table, hybridization
Calochortus monanthus Ownbey	Liliaceae	Bulbiferous perennial herb	Vernal meadows, 800 m	1876	Agriculture, grazing
Calystegia sepium (L.) R.Br. ssp. *binghamiae* (Greene) Brummitt	Convolvulaceae	Rhizomatous perennial	Coastal marshes, riverbanks, <20 m	1902[b]	Wetland change and urbanization
Castilleja leschkeana J.T. Howell	Orobanchaceae	Perennial herb	"Swampy grounds behind the dunes" <20 m	1947[c]	Unknown
Cirsium praeteriens J.F. Macbride	Asteraceae	Biennial or perennial herb	Unknown (marshes?), 10 m	1901[d]	Urbanization
Cryptantha hooveri I.M. Johnst	Boraginaceae	Annual herb	Dry coarse sand, flats and hills, <80 m	1939	Unknown
Erigeron mariposanus Congdon	Asteraceae	Perennial herb	Foothill woodland 600–800 m	1900	Special habitat requirements?
Helianthus nuttallii Torr. & A. Gray ssp. *parishii* (A. Gray) Heiser	Asteraceae	Perennial herb	Marshes, <500 m	1937[e]	Urbanization
Lycium verrucosum Eastw.	Solanaceae	Shrub	"Arroyo cliffs" <250 m	1897[f]	Unknown
Mimulus traskiae A.L. Grant	Phrymaceae	Annual herb	Unknown (Santa Catalina Is.)	1901	Grazing?
Monardella leucocephala A. Gray	Lamiaceae	Annual herb	Sandy soil grassland, interior sand dunes, 50–100 m	1941	Agriculture?
Monardella pringlei A. Gray	Lamiaceae	Annual herb	Interior sand dunes, sandy soils, 300–400 m	1941	Urbanization
Plagiobothrys lithocaryus (A. Gray) I.M. Johnst.	Boraginaceae	Annual herb	Moist habitats, 300–450 m	1899	Unknown
Plagiobothrys mollis (Gray) I.M. Johnst. var. *vestitus* (Greene) I.M. Johnst.	Boraginaceae	Perennial herb	Moist, alkaline sagebrush scrub, <50 m	1882	Unknown
Potentilla multijuga Lehm.	Rosaceae	Perennial herb	Brackish marshes, 0 m	1893[g]	Development

(Continues)

TABLE 2 (Continued)

Taxon	Family	Life form	Habitat	Last seen	Extinction driver
Potentilla uliginosa B.C. Johnst. & Ertter	Rosaceae	Perennial herb	Low-nutrient wetlands, 30–40 m	1947[h]	Agriculture and development
Ribes divaricatum Douglas var. *parishii* (A. Heller) Jeps.	Grossulariaceae	Shrub	Moist woodland, 60–310 m	1980[i]	Dry years, altered stream flows, human-caused fires, habitat loss, invasive species

[a]Besides dramatic reduction of suitable habitats, hybridization with *Atriplex serenana* Nelson ex Abrams (a native species better adapted to dry conditions) resulted in swamping of the *A. tularensis* gene pool (Freas & Murphy, 1988, 1991; Rhymer & Simberloff, 1996; R. Tollifson, personal communication, March 1, 2017). Interestingly, *A. serenana* belongs to a morphologically rather remote *Atriplex* subsection. The nearest species seems to be *A. pusilla* (Torr.) S. Watson (Olvera, 2003)—a species presumably extinct in California (see Table 2).

[b]Known only from the type locality in Santa Barbara. Erroneously reported as rediscovered in Suisun March (1965) and City of Chino (2012). Comparison with a similar recently described species, *Calystegia felix*, was provided by Provance and Sanders (2013).

[c]Known from a single plant. Possibly a synonym of *C. chrysmactis* Pennell and accidental introduction from Alaska (Hickman, 1993). However, types are rather different (F. Hrusa, personal communication).

[d]Known from only two collections from Palo Alto (1897, 1901). Thomas (1961) suggested that this was a casual introduction of a species native in the Old World. After examining the type specimen provided by the Harvard University Herbaria and sending detail pictures of that specimen to Petr Bureš, the European expert on the genus, we concluded that *C. praeteriens* is different from all European species. Dean G. Kelch, an expert on North American *Cirsium* species, suggested that the most similar native relative is *C. scariosum* Nutt. var. *loncholepis* (Petr.) D.J. Keil.

[e]Recently confused with a very similar *H. inexpectatus* D.J. Keil and Elvin.

[f]Known only from the type location. May be just a form of *L. brevipes* Benth. (Baldwin et al., 2012).

[g]Known only from one locality, Ertter (1993).

[h]Known only from Cunningham Marsh in Sonoma Co., Johnston and Ertter (2010).

[i]This is probably the most recent extinction. At least 10 specimens were collected between 1950 and 1963, Sinnott (1985).

fires (mentioned once), invasive species (mentioned once together with several other factors), hybridization (mentioned once) and drivers that are simply "unknown" (five taxa).

3.2 | Taxa extinct in California and present in at least one other state

Taxa presumed extinct in California but still present in at least one other state are listed in Table 3. The resulting numbers (15 species and 15 taxa) are higher than those in any version of the Inventory of Rare and Endangered Plants compiled by the CNPS. Most of these species are widespread (*Carex livida*—present in at least 18 US states, Canada, Eurasia and páramos of South America); only a few have very limited distribution outside of California (*Malacothrix similis* and *Mimulus latifolius* are probably only in the Baja California part of the California Floristic Province). Five species in this category were known only from higher elevations in California (>1,000 m). Only four species were known from wetlands or stream banks. All were originally known from only one or two counties. Three species in this category are known in California only from the 19th century, nine from the first half of the last century and three from the second half of the last century. Drivers of extinction in California are "unknown" for 12 taxa in this category. Agriculture, mining, off-road vehicles and development have been suggested for the four remaining species.

3.3 | Excluded taxa

A list of eight taxa excluded from the analysis is provided in Table 4. Four of them were excluded because they are now treated as synonyms of some extant taxa and four of them were recently rediscovered in California. *Castilleja leshkeana* and *Lycium verrucosum* from Table 2 may belong to this category as well.

4 | DISCUSSION

Lists of presumed extinct taxa are never finished. Some presumably extinct taxa are being rediscovered, and recent field surveys are failing to find taxa that were present a short time ago. Because of long-lasting seed banks and vegetative dormancy (Shefferson, 2009; Thompson, Bakker, & Bekker, 1997), it may be premature to pronounce many plant taxa as conclusively extinct. Compared with previously published numbers (see Introduction and Table 1), the current analysis ended with smaller numbers of globally extinct plant species and taxa (13 and 17, respectively) and larger numbers of species and taxa extinct in California, but still present outside of California (15 and 15). Interestingly, none of the presumed globally extinct plant species or taxa reported here is listed among endangered or extinct taxa in the IUCN 2017 Red List database (http://www.iucnredlist.org/search). Consequently, the surprisingly low number of extinct plant taxa included in the IUCN Red List (142; Cronk, 2016) may be the result of incomplete data.

TABLE 3 Species extinct in California but still present in at least one other state (15 species)

Taxon	Family	Life form	Habitat	Last seen	Extinction driver
Asclepias latifolia (Torr.) Raf.	Apocynaceae	Perennial herb	Dry washes, 150 m	1912[a]	Agriculture?
Atriplex pusilla (Torr.) S. Watson	Chenopodiaceae	Annual herb	Alkaline soils, hot springs, 1,500 m	1938[b]	Unknown
Carex livida (Wahl.) Wild.	Cyperaceae	Rhizomatous perennial	*Sphagnum* swamps <100 m	1866	Unknown
Corispermum americanum (Nutt.) Nutt.	Chenopodiaceae	Annual herb	Sandy soils, dunes, 900–1,200 m	1983[c]	Off-road vehicles?
Cuscuta obtusiflora Kunth	Convolvulaceae	Parasitic vine	On herbs <500 m	1948[a]	Unknown
Cuscuta veatchii Brandegee	Convolvulaceae	Parasitic vine	On *Bursera* & *Schinus*	1889[a]	Unknown
Cypripedium parviflorum Salisb.	Orchidaceae	Bulbiferous perennial herb	Shady conifer forest 1,000–1,900 m	ca. 1910[a]	Unknown
Iliamna rivularis (Hook.) Greene	Malvaceae	Subshrub	Mtn streamsides 500–2,000 m	1938[a,d]	Unknown
Malacothrix similis W.S. Davis & P.H. Raven	Asteraceae	Annual herb	Beaches, dunes, <40 m	1925	Unknown
Malaxis monophyllos (L.) Sw.	Orchidaceae	Bulbiferous perennial herb	Conifer forests, wet meadows, 2,500 m	1947[a]	Unknown
Mimulus latifolius A. Gray	Phrymaceae	Annual herb	Rocky places, <150 m	1888[a]	Unknown
Poliomintha incana (Torr.) A. Gray	Lamiaceae	Shrub	Sandy soils, rocky slopes, <1,700 m	1938	Mining activities?
Spermolepis lateriflora G.L. Nelson	Apiaceae	Annual herb	Rocky terrain, alluvial slopes, 500 m	1952[e]	Unknown
Stylocline sonorensis Wiggins	Asteraceae	Annual herb	Sandy drainages with *Prosopis*, 400 m	1930	Development?
Zeltnera arizonica (A. Gray) G. Mans.	Gentianaceae	Annual herb	Open damp places, stream banks, 70 m	1955	Unknown

[a]Baldwin et al. (2012).
[b]May be still present, field surveys needed.
[c]May be still present, it is small (3–10 cm) and easy overlooked; confused with non-native *C. hyssopifolium* L. in Hickman (1993).
[d]Recently often confused with *I. latibracteata* Wiggins.
[e]Nelson (2012).

4.1 | Some generalizations

Evaluated together, extinct taxa are represented by 13 annuals, 13 herbaceous perennials, one subshrub, two shrubs and two parasitic vines. Assuming 5,280 native vascular plant species in California (Jepson eFlora), 28 extinct species in California represent 0.53% of the native flora. Not surprisingly, most of the presumed extinct taxa were originally present in one or two counties and often are known from only one or a very few collections. Therefore, the most robust generalization regarding factors contributing to taxa extinctions is a small range size and a low original abundance. Such conditions increase a probability of extinction by chance alone (Gaston, 1994). Most of the presumed globally extinct taxa were originally present in lowlands where most of the human population and habitat destruction are concentrated. Therefore, this is the second, admittedly trivial, generalization that can be made. Nevertheless, there may be one contributing factor: the median altitude of the ranges of rare flowering plant species in California is significantly lower than that of common species (Hegde & Ellstrand, 1999). Finally, taxa limited to special habitats, like wetlands in general, or alkaline sinks in particular, seem to be more predisposed to extinction. Wetlands are also the habitats with the highest number of extinct plant species in Spain (Aedo, Medina, Barberá, & Fernández-Albert, 2015). When trying to discern determinants of plant extinctions in Auckland, New Zealand, Duncan and Young (2000) concluded that initially rare species were more likely to be extinct, and compared with tall species, short species were more likely to be extinct. Taking all 32 presumably extinct taxa in California together, 19 were <0.5 m tall and only three were >2.0 m tall. Assuming that rare taxa are more prone to extinction, this is in agreement with the analysis of Californian flora made by Hegde and Ellstrand (1999): the rare species are, on average, significantly shorter in stature than the common species (see also Gabrielová,

TABLE 4 Excluded taxa (presumed extinct in California by the CNPS Rare Plant Program, 2017; 8 species)

Species	Family	Reason
Carex scoparia Willd. var. *scoparia*[a]	Cyperaceae	Found in Plumas and Shasta Cos. in 1976 and 1982[c]
Castilleja uliginosa Eastw.[b]	Orobanchaceae	Synonym of *C. miniata* Hook. ssp. *miniata*[d,e]
Malacothamnus mendocinensis (Eastw.) Kearney[b]	Malvaceae	Synonym of *M. fasciculatus* (Torr. & A. Gray) Greene[d,e]
Malacothamnus parishii (Eastw.) Kearney[b]	Malvaceae	Synonym of *M. fasciculatus* (Torr. & A. Gray) Greene[d,e]
Mimulus brandegeei Pennell[b]	Phrymaceae	Synonym of *M. latifolius* A. Gray[d,e]
Plagiobothrys glaber (Gray) I.M. Johnst.[b]	Boraginaceae	Rediscovered by Randall Morgan in the Alameda Co. in 2002 and 2003[f]
Pyrola chlorantha Sw.[a]	Ericaceae	Rediscovered in Eldorado (1964) and Mendocino (2001) Cos.[c]
Triteleia grandiflora Lindl.[a]	Themidaceae	Rediscovered Mendocino (1993) and Glenn (1997) Cos.[c]

[a]Presumed to be locally extinct.
[b]Presumed to be globally extinct.
[c]Consortium of California Herbaria (ucjeps.berkeley.edu/consortium/).
[d]Hickman (1993).
[e]Baldwin et al. (2012).
[f]http://intermountainbiota.org/portal/collections/list.php.

Münzbergová, Tackenberg, & Chrtek, 2013). All presumed globally and locally extinct species were monoecious, and most of them very likely insect-pollinated. Only *Atriplex latifolia*, *A. tularensis*, *Carex livida* and *Corispermum americanum* were wind-pollinated. Dependence on specialist pollinators or seed dispersers makes flowering plants prone to extinction (Bond, 1995). However, so far, there is no indication that the loss of pollinators was an important factor in plant species extinctions in California. Even *Cypripedium parviflorum* (Orchidaceae) has many documented non-specialized pollinators (Argue, 2012). There does not seem to be any particular dispersal mode associated with presumably extinct plants in California. Only two extinct taxa were primarily dispersed by non-specialized vertebrates (*Lycium verrucosum* and *Ribes divaricatum* var. *parishii*). The loss of phylogenetic diversity is expected under some environmental change scenarios (Zhang et al., 2017). Fortunately, so far, this does not seem to be occurring in California. In general, presumed globally extinct plant taxa represent several relatively different species-rich genera in California (Table 2).

It is clear that environmental degradation is the main factor responsible for plant extinctions, irrespective of their traits (see also Godefroid, Janssens, & Vanderborght, 2014). Among assumed drivers of plant extinction in California, agriculture, urbanization and development in general are cited most frequently (Tables 2 and 3). Surprisingly, in the CNPS Inventory, "invasive species" are mentioned only once and only in combination with several other factors (*Ribes divaricatum* var. *parishii* in Table 2). A similar rating of the probable causes of plant extinctions is available for Spain's 27 extinct taxa (Aedo et al., 2015): habitat loss (16 taxa), overgrazing (2) non-native plant species (1) and unknown (8). These two assessments are in noticeable contrast with extinction-driver ratings in some publications (Bellard, Cassey, & Blackburn, 2016; Tershy et al., 2016; Wilcove, Rothstein, Dubow, Phillips, & Losos, 1998). However, such ratings are based mostly on biodiversity impacts of animal invaders, namely predators and grazers. Moreover, the most convincing cases of plant extinctions associated with plant and animal invasions are from islands where joint effects of grazing, changes in fire regime and plant invasions are the major threats (Hernández-Yáñez et al., 2016). There are over 1,000 established (naturalized) non-native plant species in California (Rejmánek, 2012), but their presence is usually associated with some form of human-created disturbance. Indeed, one needs quite a bit of imagination to predict that any native plant species may be driven to extinction by invasive plants per se (Downey & Richardson, 2016; Gilbert & Levine, 2013). On the other hand, there is no doubt that invasive plant species contribute to the endangerment of native plant species in concert with other factors like livestock grazing, outdoor recreation and residential development (Didham et al., 2005; Hernández-Yáñez et al., 2016). The major challenge for ecologists working on plant invasions is to quantify the extent of this contribution. Also, it is possible to argue that the impact of invasive plant species starts to be more important only now when they are becoming more widespread and their impact, in terms of potential taxa extinctions, will be more important in the future. Moreover, we may expect combined cumulative negative effects of continuing climate change, particularly the increase in drought severity and abundance of invasive plant species (Pfeifer-Meister et al., 2016).

4.2 | Comparison with other countries

Compared with other areas with mediterranean-type climates, plant extinctions in California do not seem to be exceptional. While 55 and

52 extinct taxa were reported from Western Australia in early assessments (Greuter, 1994; Hobbs & Mooney, 1998), only 23 taxa and 14 species were reported later (Coates & Atkin, 2001; Government of Western Australia, 2007). On the other hand, 36 extinct vascular plant species were reported from Israel recently (Essl et al., 2013). The proportion of extinct plant species in California (0.53%) is much lower than the average proportion of extinct species in 38 European countries: 2.05% (Essl et al., 2013). However, in this case, most of the counted extinct species are only nationally extinct but are still present in other European countries. Moreover, if we calculate the mean proportion of nationally and globally extinct vascular plant species just in European Mediterranean continental countries (Croatia, France, Greece, Italy, Portugal, Slovenia, Spain), the proportion is much smaller, almost identical to California: 0.55% (data from Essl et al., 2013). Based on Greuter (1994), there are 33 globally extinct taxa (31 species and two subspecies) in the Mediterranean (just 0.11% of the estimated total native flora). Californian numbers are very similar to the Cape Province of South Africa: 33 extinct plant taxa representing 28 species (J. Le Roux, personal communication). The situation seems to be very different in Chile where many species have been assumed extinct, but were rediscovered later (M. Arroyo, personal communication). Currently, based on the Ministerio del Medio Ambiente databases (www.mma.gob.cl), 17 Chilean endemic plant species are classified as extinct. Eight of these were in the northern deserts, six on the Juan Fernandéz islands, two on the Easter Island and one, a subalpine species, in the Metropolitan Region, which has a mediterranean-type climate. However, correct identity of the later taxon (*Tristagma leichtlinii* (Baker) Rav.) is questionable (Arroyo-Leuenberger & Sassone, 2016). One possible reason for this difference is that mediterranean Chile has fewer locally restricted endemics than California (M. Arroyo, personal communication).

Critical evaluations of rare, threatened and extinct taxa as they have been continuously provided by the CNPS (Table 1) and in the analysis of extinct taxa presented in this article (Tables 2 and 3) represent the first inevitable steps in conservation efforts and may serve as models for other countries. Nevertheless, these are just the first steps. Currently, recognized plant extinctions in the majority of countries should encourage preserving remnants of native vegetation (Godefroid & Koedam, 2003; Hahs et al., 2009), more recovery plans (Zeigler, Che-Castaldo, & Neel, 2013), seed banking (Meyer, Jensen, & Fraga, 2014), monitoring (Levine, McEachern, & Cowan, 2008) and reintroductions (Guerrant & Pavlik, 1998) of all critically endangered taxa.

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