

## Original Research

# Using population characteristics to evaluate the conservation status of endangered grassland species – The case of *Herbertia zebrina* in southern Brazil



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## ABSTRACT

Many plant species listed as endangered by IUCN do not have information on population characteristics and reproductive traits, although such data are needed for conservation classification. This paper revisits the conservation status of a 'critically endangered' species in fragmented grasslands of southern Brazil. We present the case of *Herbertia zebrina* (Iridaceae), a geophyte first described in grasslands on granitic outcrops in 2010. We identified 18 populations within an estimated range of about 5000 km<sup>2</sup>. Data on population size, plant size, fruit production and germination were recorded for three representative populations with repeated sampling of labelled flowering plants over a period of two years. Population size was 1869–14,555 flowering plants (2.2–3.5 plants m<sup>-2</sup>) with considerable turnover between years. Among populations, 11–61% new flowering individuals emerged in the second year, while 27–46% of the first-year plants were not observed in the following year. The plants emerged in early spring in both years and flowered over a period of four months. The number of fruits was positively correlated with plant size and vegetation height, while germination was about 86%. Thus, the number of populations, area of occupancy and plant reproduction indicate a more favourable conservation status than previously assumed. Nonetheless, due to population fragmentation and the rapid loss of natural ecosystems in the region because of land-use change, the overall classification of the species as 'critically endangered' should be maintained. Future research has to focus on implications of fragmentation on genetic variation among populations.

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## 1. Introduction

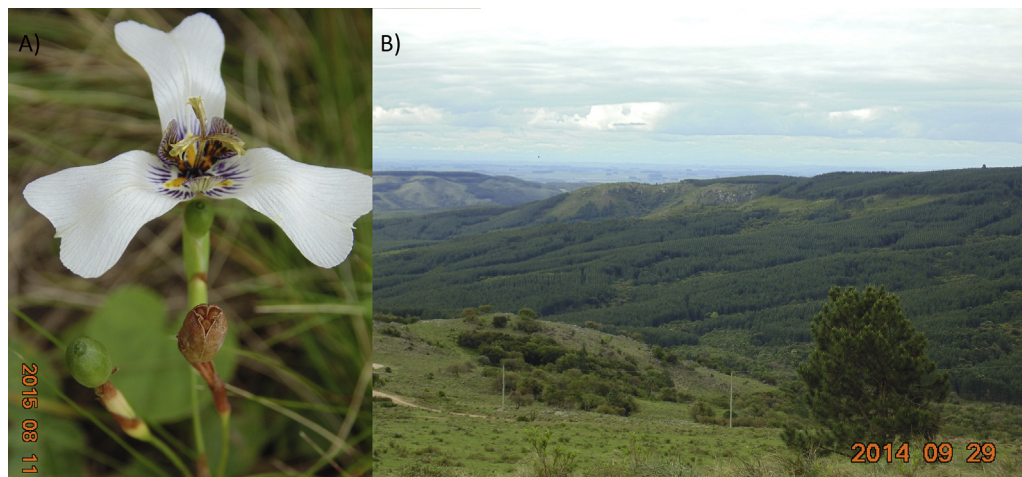
Worldwide, more than 8% of the plant species are currently threatened with extinction (Chapin et al., 2000). Changes in land use are among the most significant drivers of declining biodiversity (Sala et al., 2000), and habitat reduction and fragmentation have been recognized as the main direct factors of reduced population size (Wilson et al., 2016). Fragmentation can also have negative consequences on reproduction, which in the long term will increase the extinction risk of small populations (Aguilar et al., 2008). However, for many 'threatened' species there is a lack of data on population

characteristics and reproductive traits that are needed for reliable estimates of their actual conservation status.

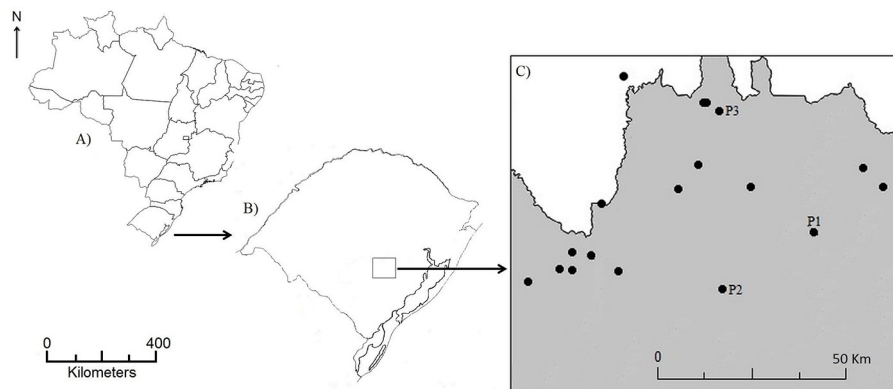
Population studies are essential to define the Red List status of individual species. The IUCN Guidelines on Red Lists of Threatened Species (IUCN, 2001) use five criteria to determine whether a taxon is threatened or not. In general, species are evaluated based on range size, population number and size, and degree of fragmentation. Similar criteria were already suggested by Rabinowitz (1981), intended to define rarity and are still the most common measures to describe the extinction risk of species. Approximately 31% of the species included in the IUCN Red list are classified as threatened because of reduction in habitat size and increasing fragmentation (IUCN, 2017). However, for annual species with seed banks or for geophytes, estimating population size can be challenging, because of variation among seasons and years due to dormancy. Moreover, although the criteria of IUCN highlight the importance for popu-

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**Fig. 1.** (A) Flower and fruits of the endangered geophyte *Herbertia zebrina* that occurs in permanent highland grasslands of southern Brazil. (B) Landscape showing the grasslands covering granitic hills. Recently established pine plantations cause habitat loss and fragmentation within the endemic range of the species.



**Fig. 2.** Study region of the endangered study species *Herbertia zebrina*. Map of Brazil (A), the Brazilian state Rio Grande do Sul (B), and at the border between granitic highlands (grey) and lowlands (white), both naturally covered by grasslands (C). In a systematic survey, a total of 18 populations of the species were identified (black points), of which P1, P2 and P3 were used for studies of the factors controlling plant reproduction.

lution viability over several generations, reproductive success is rarely evaluated for including species in Red Lists. Studies on populations of some endemic species have shown that reproduction and germination can be lower when compared with widespread species within the same family (Devoto and Medan, 2003; Brown and Botha, 2004; Carta et al., 2014). Therefore, analyses of population fluctuations and reproductive potential should be considered when classifying species as threatened or not.

The grasslands of southern Brazil include ecosystems with a particularly high number of plant species (Boldrini, 2009), many of them rare and listed as threatened (Red List RS, 2014). At the same time, the grasslands are severely affected by land-use change that can lead to ecosystem degradation (Andrade et al., 2015); protection is inefficient and conservation management poor (Overbeck et al., 2007, 2015). Moreover, the knowledge about grassland composition is sparse, hence many species are insufficiently described, and studies of their population characteristics are missing. A special feature of these grasslands is a long and asynchronous phenology for many plant species, most likely due to a short cold season and presence of different temporal niches (Oleques et al., 2017). Another challenge for understanding population dynamics might be fluctuations in plant abundance and degree of flowering over years, and more research is needed on this topic. Thus, these subtropical grasslands are complicated study systems, not only because of the emerging conservation needs, but also because the

basic understanding of population dynamics of threatened species has to be improved.

Due to its diversity, the Iridaceae are a prominent family present in the grasslands in southern Brazil (Iganci et al., 2011). Many species of this family have very specific habitat requirements. They occur in small populations or have a restricted range (Munguía-Lino et al., 2016), and many are endemic (Iganci et al., 2011; Aita et al., 2013). Some Iridaceae are negatively affected by changing land use, and populations have been markedly reduced by habitat fragmentation in past decades (Volis et al., 2010). Many Iridaceae in Brazil are considered threatened (IUCN Red List), and the systematic position of some taxa still not been well resolved (Chauveau et al., 2011; 2012; Lovo et al., 2012). Thus, there is an urgent need to improve the knowledge of the conservation status of members of this family in the grasslands of southern Brazil.

The study investigates population characteristics and reproductive traits of *Herbertia zebrina* Deble, an Iridaceae first described in 2010 (Deble, 2010), with the aiming to evaluate its conservation status. Because of its limited range size and few known populations, it is considered as 'critically endangered' (Red List RS, 2014). Specifically, it is classified as B1ab (iii,v) as a result of its small occurrence area, estimated to be less than 100 km<sup>2</sup>, together with high fragmentation of populations and ongoing losses in population size (IUCN, 2001). Here, we investigate principal aspects of the population biology of the species and aim to re-evaluate the IUCN classification using data on distribution size, population

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