Criteria to select vegetal species for restoration of plant-pollinator interactions in agricultural landscapes of the Pampa grassland (Argentina)

Sabatino Malena [1], Adriana Rovere [2], Paula Meli[3]

[1] Centro de Investigación en Abejas Sociales (CIAS). Instituto de Investigaciones en Producción Sanidad y Ambiente (IIPROSAM - CONICET). Facultad de Ciencias Exactas y Naturales. Universidad Nacional de Mar del Plata. Funes 3350 (7600) Mar del Plata. Buenos Aires. Argentina. https://orcid.org/0000-0001-8726-601X

[2] Instituto de Investigaciones en Biodiversidad y Medioambiente (INIBIOMA, CONICET-UNCOMA). Quintral 1250. San Carlos de Bariloche (8400), Río Negro, Argentina. https://orcid.org/0000-0002-9811-1192

[3] Laboratorio de Ecología del Paisaje y Conservación, Departamento de Ciencias Forestales. Universidad de La Frontera. Av. Francisco Salazar 01145, Temuco 4811230, Chile.

https://orcid.org/ 0000-0001-5390-7552

Correspondence

Email: malenasabat@gmail.com

Abstract

Through the use of targeted planting species to attract and sustain pollinators, a range of ecological functions including pollination services could be successfully restored in degraded ecosystems. In this study, we propose a procedure to select target species for restoration of plant-pollinator interactions in agricultural landscapes, which is illustrated by a case study of the Southern Pampas grassland (Argentina). Based on a large pollination network dataset of 12 hills sampled, composed by 172 pollinators and 96 plants, we identified plant species playing a major role in the maintenance of pollination mutualisms. We obtained a ranking of the interaction frequency for each of the 96 plant species of the metaweb and native plants that received more than 100 individual flower visitors were selected. Targeted species were studied using ten criteria related to ecological, technical and cultural information, and then integrated into a species valorization "index for interaction restoration" (IIR). From the total plant species (96) registered for all sampled hills we identified a total of 24 plant species, which represent 90% of the total interactions and 25% of the plant species recorded in the metaweb. Six out 24 selected species were excluded since they were non native, resulting in a total of 18 targeted native plant species. The IIR value ranged between 8 and 2.68 with a mean of 4.63 ± 1.40. The two species genera with the highest value for the IIR (*Eryngium* sp. and *Baccharis* sp.) have been recognised to be potential candidates for restoration in other ecosystems. An index that valorises plant species capable of rehabilitating plant-pollinator interactions will be a solid basis for planning a restoration project, which is crucial for biodiversity conservation and rehabilitation sustainability.

Keywords: keystone species, ecological criteria, germinative requirements, plant uses, pollination networks, Southern Pampas-Argentina.

Introduction

Rehabilitating degraded or altered ecosystems could require reintroducing native species that have been lost to facilitate the recovery of ecosystem processes and services (SER, 2004). In particular, the use of entomophilous native plants helps to recover ecosystem integrity, since they offer floral resources to beneficial insects that provide valuable ecosystem services, including pollination (Isaacs et al. 2009). Animal-mediated pollination constitutes a critical process for the functioning of many ecosystems and represents an important ecological service in agricultural landscapes (Costanza et al., 1987; O'Toole, 1993). The temperate grassland biome is globally significant for its endangered biodiversity and important to agricultural production (Sala & Stuart, 2000), and was recently reported to be the biome with the lowest biodiversity integrity in the world (Newbold et al., 2016). Native grasslands were highly modified by anthropic activity, with agriculture intensification being one of the main drivers of land-use transformation of natural environments (Herrera et al., 2009). The consequent habitat fragmentation and degradation have been responsible for global biodiversity loss (Sala & Stuart, 2000) including the pollinator decline (Aizen, Sabatino, & Tylianakis, 2012; Potts et al., 2010; Ricketts et al., 2008; Winfree et al., 2009). Given the importance of biotic pollination and its sensitivity to anthropic disturbance, it is fundamental to consider the role of native plant communities and their pollinators in ecological restoration practices. In this way, generating criteria to select species for ecological restoration of plant-pollinator interactions would contribute to rehabilitating the ecological functions and services provided by the species involved.

There is a wide variety of criteria to select target species for restoration, which depend on the ecosystem to be restored and the particular needs of each project (Meli et al., 2014). The selection of species to be included for restoration of plan-pollinator interactions is important since restoration plans are limited in terms of resources and so they must focus on a limited list of plant species. In general, only a few plant species receive most pollinator visit (Winfree, 2010) and the most attractive species might be better to target for restoration purposes. For this reason, we must focus on recovering those plant species that are highly attractive for pollinators, such as “framework” or “bridging” species, before increasing the general species richness. Framework plants support pollinator communities by providing considerable nectar and/or pollen resources to numerous pollinator species and individuals, while bridging plants provide nectar and pollen resources during bottlenecks of resource availability (Dixon, 2009; Menz et al., 2011). Plant species that attract fauna (pollinators and seed dispersers) by offering resources can foster the formation of regeneration niches and colonization of new populations through facilitation, generating new connections in the degraded landscape (Garcia, Zamora, & Amico, 2010; Reis, Bechara, & Tres, 2010). The knowledge of the organisation of temporal and spatial plant resources within communities is fundamental to rehabilitate ecological function, as well as their interactions with animals, like pollinators and dispersers (Talora & Morellato, 2000). The study of mutualistic assemblage of plant communities through the construction of pollination networks allows us to analyse the species composition and identify the ecological role of plant species and the types of interactions in which they participate (Bastolla et al., 2009; Vázquez et al., 2009). Therefore, spatial availability of resources is relevant to determine network structure and its variation in the landscape. It has been shown that flower abundance is important for pairwise interactions and that locally frequent interactions are more consistent across space (Carstensen et al., 2014). Similarly, interaction frequency is a good proxy for trait complementarity and behavioural preferences between species pairs, when detailed information on species-specific traits and how they would combine in the given system is lacking (Poisot et al., 2011).

Another basic criterion to select species for restoration is preferably the exclusive use of native species (Sabatino, Maceira, & Aizen, 2010), given that the use of native plants has many advantages, including their adaptation to local conditions as well as the role they play in sustaining pollinators, dispersers and natural predators (Isaacs et al., 2009). Regarding the life forms, perennial native shrubs could be employed as nurse plants in restoration activities, since they facilitate the establishment and growth of other species beneath their canopy by habitat amelioration (Gómez−Aparicio, 2009; Padilla & Pugnaire, 2006). Seed dispersal is recognised as another key ecological process in community assembly, and can occur through a variety of vectors such as wind (anemochory), plant's own means (autochory) and animals (ectozoochory and endozoochory) (Van der Pijl, 1982; Vittoz & Engler, 2007). The dispersal strategy significantly influences species colonising success in a restoration process and has been demonstrated to be positively related to the ability of species for long-distance dispersal (Bochet & García-Fayos, 2015). Likewise, information concerning species reproductive characteristics, such as natural regeneration potential and germinative requirements for sexual propagation, is indispensable to optimize the identification of suitable plant species for restoration (Meli et al., 2014). Moreover, native plant species have a great utilitarian potential, which should be taken into account in rehabilitation planning that adopts conservation through utility as a strategy (Molares & Rovere, 2014). The knowledge about native plant uses that the populations inhabiting the restoration area have is of great importance for their valorization and potentially determinant of successful ecological restoration programmes (Garibaldi & Turner, 2004; Rovere, Molares, & Ladio, 2013).

The plant community of the Tandilia hills system, along with remnant grassland patches, is the most relevant natural habitat for the sustainability of diversity in the agroecosystem of the Southern Pampas of Argentina (Barral & Maceira, 2011). Fragmentation of the pampean landscape due to agricultural expansion has led to the loss of different ecosystem services and changes in habitat quality. Native grasslands have been mostly replaced by annual crops, except for some small isolated fragments that remain near the hills due to the presence of rock outcrops that preclude tillage (Herrera & Laterra, 2011). Many of the plant species inhabiting the hills ensure the presence of floral resources throughout the year and constitute an important resource to pollinator populations conservation, favouring pollination services to nearby crops (Sáez, Sabatino, & Aizen, 2012). To recover the structural elements or functions of an altered ecosystem, it is necessary to know the floristic composition and dynamics of native vegetation types (Ruiz−Jaen & Aide, 2005), as well as the interspecific interactions that occur in the community (Sabatino, Rovere, & Maceira, 2015).

In this study, we propose a procedure to select target species for restoration of plant-pollinator interactions in agricultural landscapes, which is illustrated by a case study of the Southern Pampas. In this context, the aims of this work were 1) to identify the set of native plant species with the highest diversity of flower visitors in pollination networks; 2) to assess, in this plant set, the species relevant for restoration on the basis of ecological, technical and cultural criteria; and 3) to integrate such criteria into a species valorisation index for interaction restoration (IIR). The results of this work will contribute to developing the Strategic Plan for Biodiversity 2011-2020 (Convention on Biological Diversity, 2011), which aims to improve the status of biodiversity by safeguarding ecosystems and species and to enhance the benefits to all from biodiversity and ecosystem services.

Methods

Study system and dataset

The study area is located in the Southern Pampa region of Argentina within the Tandilia hills System (Cabrera & Willink, 1973). The croplands surrounding the hills, originally an extensive grassland, are dominated by agricultural fields cultivated with cereal crops and oil seeds among others, and used for cattle production under low input farming conditions (Soriano, 1991; Viglizzo et al., 2001). Despite being highly disturbed due to cattle grazing, fire, herbicide and species invasion, these hills still preserve many floristic elements that used to be common in the surrounding plains and elsewhere in southern South America, representing important hotspots of biodiversity (Gilarranz, Sabatino, Aizen, & Bascompte, 2015). The climate of the region is temperate with no or small water deficiency, with a noticeable seasonal variation in temperature and a short cold period (Burgos & Vidal, 1951). Soils are typical Argiudoll and Hapludoll developed from loessic deposits over quartzite rocks (INTA, 1991).

We surveyed pollination webs from 12 hills located between Mar del Plata (37º58' S, 57º35' W) and Balcarce (37º50' S, 58º15' W), Buenos Aires Province, Argentina. The area of the studied hills and their distances to the nearest hill neighbour are representative of the range in size and isolation of the whole orographic system. The hills have rich vegetation characterised by a gentle, basal rocky slope dominated by shrubs, herbs and geophytes, a barely vegetated steep scarp, and a flat top with a mosaic of exposed bedrock and loessic patches dominated by grasses. The most abundant and diverse plant families are insect pollinated (i.e. Asteraceae, Apiaceae, Fabaceae and Scrophulariaceae). The hills support a rich flower-visitor community that comprises mainly insects (Hymenoptera, followed by Diptera, Coleoptera and Lepidoptera) (Aizen et al., 2012; Sabatino et al., 2010). Apiculture with European honey bee *(Apis mellifera*) is also an important economic activity in areas of the surrounding matrix (Sáez et al., 2012).

Fieldwork was conducted during the 2007–2008 flowering season (September–April). In each studied hill, we set a sampled area of 0.5 ha on the north-facing slope, about 200 m from the edge of the nearest agricultural field. This sun-exposed slope presents the highest plant diversity among the hill habitats. In each sampled area, we set ten permanent 1 m radius plots, about 25 m apart, along two parallel 100 m transects separated by 50 m. Within each plot, we identified all blooming angiosperm species and recorded all flower visitors that contacted floral sexual organs during a 15-min period. All plots from a given hill were sampled consecutively between 9 a.m. and 6 p.m., and each hill was sampled an average of ten times throughout the flowering season, once every 2 weeks, for 318 h of observation distributed over 127 days. In total, we recorded 13174 flower visitors belonging to 172 animal species, which interacted with 96 plant species. Only the visited plant species were included in the analyses. All flower visitors were morphotyped and identified with the aid of a reference collection and specialist help at least to the family level (Sabatino et al., 2010). The plant–pollinator interaction matrices for each of the sampled hill, the metaweb, and the area and coordinates of each hill, are available from the Dryad Digital Repository:http://dx.doi.org/10.5061/dryad.cr3ft (Gilarranz et al., 2014).

Previous studies in this system showed that trends in number of species and interactions, as well as in overall network architecture and phylogenetic structure of pollination webs, could be predicted based on meta-community dynamics (Aizen et al., 2016; Aizen et al., 2012; Gilarranz et al., 2015; Sabatino et al., 2010). This results provided a rule of thumb related to the amount of area that should be protected if we were interested in conserving a minimum number of species and interactions (Gilarranz et al., 2015; Sabatino et al., 2010). Furthermore, we found evidence that two traits, interaction frequency (number of individual flower visitors to a particular plant species observed during the study) and degree of generalization (average number of species with which the plant and pollinator interact), permit us to predict the nonrandom loss of interactions with decreasing hill size. Interactions occurring at low frequency and between specialist are the most likely to be lost in small hills, whereas frequent interactions and/or interactions between generalists should be more resistant to habitat reduction and, therefore, be more ubiquitous in habitat fragments of all sizes (Aizen et al., 2012).

Based on the metaweb of the 12 hills sampled, composed by 172 pollinators and 96 plants, we identified plant species playing a major role in the maintenance of pollination mutualisms, in terms of the diversity of interactions in which they participated. We obtained a ranking of the interaction frequency for each of the 96 plant species of the metaweb and native plants that received more than 100 individual flower visitors were selected (Fig. 1).

Criteria and methodology

To assess the relevant plant species for restoration of plant-pollinator interactions, we considered those attributes that allow us to accelerate the ecological rehabilitation processes. These attributes are related to the plant capacity to attract fauna as well as to increase the ecological and functional diversity. We studied ten criteria based on ecological, technical and cultural information of the selected plant species from which the IIR was estimated.

1) Interaction frequency (IF) evaluates plant species by the number of individual flower visitors they received and allows us to identify the species that are highly attractive for pollinators. This criterion was standardised by dividing the number of flower visitors

received by each plant by the total number of flower visitors (13174) registered for all sampled hills.

2) Interaction richness (IR) evaluates plant species by the number of pollinator species they received, and together with the IF criterion, it brings us information about the diversity of interactions associated with a floral resource. For its standardisation, we divided the number of pollinator species received by each plant by the total number of animal species (172) registered for all sampled hills.

3) Flowering phenology (F) evaluates the temporal availability of floral resources for pollinators throughout the year. Plant species with an extended flowering season ensure the availability of pollinator resources for a longer period of time. Similarly, plant species that blossom early in spring (September-October) or later in autumn (March-April) are important to provide resources during shortage time, when the flowering peak is over. According to field observations and the literature (Albuquerque et al., 2013), plant species with a flowering period equal to or longer than 4 months received a high value (3), whereas those species with early or late blossom during season had an intermediate value (2). Plants without any of these attributes received a low value (1), while those with both attributes received the sum of both values (5).

4) Spatial consistency (C) assesses the spatial availability of floral resources for pollinators. Plant species that are consistent in the landscape usually show high interaction frequency, since they are locally abundant and have a higher probability of encounter with the pollinators (Carstensen et al., 2014). Thus, plant species present in a greater number of hills was valued, since they offer evenly distributed resources in a fragmented landscape. The spatial consistency for a given plant species was estimated by dividing the number of hill webs in which it was present by the total number of sampled hills. The C is a continuous variable that varied between 0 and 1.

5) Endemism status (E) considers the biogeographic distribution of species giving special attention to native species whose geographic range is restricted to the Pampa region, due

to their biodiversity conservation value. It was determined by using the Catalog of Vascular Plants of the Southern Cone (Zuloaga, Morrone, & Belgrano, 2009) databased. A high value was assigned to endemic species (2) and a low value to native ones (1).

6) Life form (L) assesses the growth form of plant species and values the potential role of shrub species as vegetation islands in a nucleation process. In addition to offering flower resources to pollinators, native shrubs can act as nurse plants and provide refuge for birds and other animal species. Shrub species obtained a high value (2), whereas herbs and subshrubs obtained a low value (1).

7) Dispersal strategy (D) involves the ability of plant species to long-distance dispersal in relation to colonizing success. According to field observations and a review of the literature, selected species were assigned to two broad dispersal categories depending on the dispersal vector (Bochet & García-Fayos, 2015): long-distance dispersal including anemochorous or wind-dispersed species received a high value (2), whereas short-distance dispersal concerning autochores or self-dispersed species received a low value (1).

8) Vegetative reproduction (VR) considers the presence of plant structures, such as rhizomes or xylopodium, which promote plant sprouting ability. These structures have been shown to favour plants on disturbed lands (Bochet & García-Fayos, 2015), and to promote their implantation when the germinative potential of the species is low. This attribute was determined from field observations and confirmed through a literature review (Cabrera & Zardini, 1978; Zuloaga et al., 2009). Thus, a high value (2) was assigned to the species that present vegetative reproduction and a low value (1) to those that do not present this attribute.

9) Germination requirements (GR) assess the technical constraints for seed germination of target species. We collected seeds from the available species selected at the sampled hills and then germinated them under different treatment requirements (control, mechanical scarification, and cold stratification treatment). Species that showed a germination percentage higher than 50% without requiring a pre-germination treatment received a hig-

her value (3) than species that required some treatment to reach the same rate of germination (2). Those species whose germination percentage was lower than 50%, with or without treatment, received a low value (1).

10)Plant uses (U) was valued according to the different types of cultural uses attributed to plant species. The uses of each species were obtained from an exhaustive bibliographic review and were grouped into 5 categories: medicinal, ornamental, edible, fuel, and other uses (crafts, detergent, dye, fodder, etc.). The criterion value was calculated by summing the categories of use for each plant species and ranging them between 1 and 5.

Estimation of index for interaction restoration (IIR)

We integrate all the information into a simple index considering all criteria equivalent. To compare the studied criteria and unify the value scales, since some were continuous and others ordinal, we standardised each criterion according to *(X-Xmin)/(Xmax-Xmin)*, where *Xmin* and *Xmax* are the minimum and maximum values among all plant species recorded for a given criterion. Thus, the IIR of each selected plant species was estimated with the formula:

IIR = IA + IR + F + C + E + L + D + VR + GR + U

where, IA: interaction abundance; IR: interaction richness; F: flowering phenology; C: spatial consistency; E: endemism status; L: life form; D: dispersal strategy; VR: vegetative reproduction; GR: germinative requirements; U: plant uses.

Results

Species selection and criteria analysis

From the total plant species (96) registered for all sampled hills, we identified those species that received more than 100 individual flower visitors. These plant species represented 90% of the total interactions and 25% of the plant species recorded in the webs. We identified a total of 24 plant species, six of which were excluded since they were non native, resulting in a total of 18 selected native plant species, for which the criteria were analysed and the IIR estimated (Fig. 1). Interaction frequency in selected species varied between 131 and 3208, *Eryngium regnellii* being the most widely visited and the only one with more than 1000 visits (Appendix S1). Interaction richness for selected species ranged between 19 and 86, comprising 94% of the total species of pollinators registered in the metaweb and including a diversity of taxa of pollinators (Hymenoptera, Diptera, Coleoptera and Lepidoptera) (Fig. 1). For the rest of the sampled plant species of the metaweb the number of pollinator species was lower than 10 in 62% of the cases.

In particular for the 18 plant species selected, flowering phenology was extended for more than four months in seven of them (38%) including the spring and summer season, whereas in two species (11%) blossom was early, and it was belated in four species (22%) (Table 1). Regarding spatial consistency, 72% of the species were found in more than six hills while only one plant species (*Hatschbachiella tweedieana*) was exclusive to one hill (Fig. 2). Seven species had endemism status, representing 19% of the total endemic species registered for all webs (Table 1). In terms of life form, six species were herbs, three were shrub and the rest were subshrub (Table 1), all species being perennial. All plant species selected, except for two, presented anemochorous dispersal syndrome, associated with three fruit types: achene (Asteraceae), mericarp (Apiaceae) and loculicidal dehiscence capsule (Orobanchaceae). The remaining two species showed autochorous dispersal strategy and had explosive dehiscence fruits (Table 2). Eight of the selected species can reproduce in a vegetative manner through rhizomes and xylopodium, and most of the woody species as well as the perennial herbs were included in this group (Table 2). Germinative requirements were evaluated for 14 of the selected species, eight of which presented a germination percentage higher than 50% without pre-germinative treatment, whereas two species (*Lathyrus pubescens* and *Senecio bravensis*) needed mechanical scarification treatment to reach the same percentage. These species do not germinate unless the seed coat is physically damaged, which in our system may due to physical abrasion of the seed coat in the rocky soil (personal observation). In four species, the germination percentage was low for treatments and control. We did not have suitable information about the germinative requirements of 22%

of the species (Table 2). Among the literature sources consulted to obtain the uses of the selected plants, ornamental uses were the most frequent (83%), followed by medicinal uses (78%). Records of plants used as food (edible) and firewood (fuel) were 28% and 22% of the total, respectively, while other use categories represented 17% of the records (Table 2).

Index for interaction restoration for selected species

The IIR was calculated for the 18 plant species selected to assess their potential for use in restoration of plant-pollinator interactions in agricultural landscapes. The IIR value ranged between 8 and 2.68 with a mean (±SD) of 4.63 ± 1.40. The IIR average was near the median value and 50% of the species scored an IIR higher than the mean (Table 3). *Eryngium regnelii* was the species with the highest IIR and it showed the uppermost values of abundance and richness interactions, followed by *Baccharis dracunculifolia* and *Chromolaena hirsuta*.

Discussion

In this study, we propose a procedure to target native species for restoration of plan-pollinator interactions and ecosystem processes in agricultural landscapes. Based on a large dataset of pollination network from the Tandilia hills System in the Southern Pampas, we identified the plant species with the greatest interaction frequency and richness of flower visitors. The resulting targeted species were studied using ten criteria related to ecological, technical and cultural information, and then integrated into a species valorisation "index for interaction restoration" (IIR). We calculated IIR considering all criteria equivalent, given that our goal was to select and characterize target species with potential use in rehabilitation of ecosystem functions as pollination, rather than evaluate differential weight or possible relation between criteria. Valorisation of plant species for the rehabilitation of plant-pollinator interactions through the creation of an index will provide a solid basis for planning a restoration project. The criteria to be used could be adapted to other grassland ecosystems and different ecological conditions, and enriched as new information is generated. For example, in the Central Valley of California a large dataset on plant-bee interactions from farms and natural area sites was used to select plants that would support the most important crop pollinator, with the aim to restore a range of ecological functions including pollination services (Menz et al., 2011). However, the most appropriate methodology to select target species for restoration will depend on the main aims and on information availability as well as the ecosystem features.

Network approach allows us to identify individual plant species that are well linked to many other species and this kind of information can be used in restoration management, since some plant taxa can potentially lead to disproportionate gain in biodiversity (Pocock, Evans, & Memmott, 2012). Interaction frequency is partly determined by species abundance, so that abundant animal species tend to interact more frequently than rare species (Vázquez, Morris, & Jordano, 2005). In this manner, the knowledge of the diversity of pollinators with which the plant interact will allow us to estimate its relevance for use in ecological restoration. Furthermore, identifying generalist plant species with an extended flowering phenology can be important if the main objective of a restoration project is to focus on the rehabilitation of pollinator interactions with relatively low specific food requirements. Although the necessity for bridging plants varies between ecosystems, it is most important in communities with pollinators that require pollen or nectar all or most of the year, such as some vertebrate pollinators and social and/or multivoltine bee species such as bumblebees (Menz et al., 2011). Likewise, spatial consistency of floral resources for pollinators is key for maintaining viable populations in a fragmented landscape like the Southern Pampa region. Landscape connectivity is also critical for conservation of entomophilous plant species assemblage, as was demonstrated in a study conducted in the Tandilia hill System where some grassland patches (hills and small rocky outcrops) were found to play a crucial role for overall connectivity (Herrera et al., 2017a). Besides, the location of small habitat patches in the grassland network allowed them to function as stepping stones, yielding significant connectivity gains for species that disperse large distances (Herrera et al., 2017b).

The data about seed dispersal mechanisms of target species can be used in restoration projects to understand which species might require active re-establishment and which might passively recolonise degraded sites (Pausas & Lavorel, 2003). For example, regenerating species in disturbed sites are frequently those with small seeds, which are widely dispersed (Chazdon et al., 2007). Similarly, concerning other species traits such as longevity and vegetative propagation, assemblages of species with short-lived and non-clonal plants are characterised by their dispersal capabilities and ability to respond to unfavourable conditions such as changes in habitat quality or isolation (Lindborg et al., 2012). However, plant species with underground storage organs such as rhizomes, bulbs, tuberous roots, and xylopodia can provide not only the regeneration of individual plants after seasonal droughts or other environmental disturbance, but also a high rate of vegetative propagation and local dispersal because of the existence of a bud bank (Clarke et al., 2013; de Moraes et al., 2016). Species that showed a great capacity for resprouting after plant damage, as found for *Eryngium horridum*, have been demonstrated to be a strategy of great importance for the survival of populations (Fidelis et al., 2008). Therefore, vegetative reproduction seemed to be an important strategy for the maintenance and survival of populations, allowing longer population persistence over time, even in the absence of disturbance. These aspects are particularly relevant in target species under endemic or conservation status, since threatened or endangered species may not bear additional reduction in their populations through seed harvesting and it would be more efficient and less ecologically costly to perform vegetative propagation (Meli, Martínez-Ramos, & Rey-Benayas, 2013). Further research about alternatives for the introduction of selected plant species in the field is needed in the way to identify the species that can be direct seeding or need to be propagated in a nursery before being transplanted to the site to be restored. This kind of study would provide important information to estimate the cost and effort to begin a restoration project in the future.

Restoration projects in human-dominated ecosystems prioritizing ecological criteria and cultural values to select species are crucial for biodiversity conservation and rehabilitation sustainability (Meli et al., 2014). In our case study, the two species with the highest value for the IIR (*Eryngium regnellii* and *Baccharis dracunculifolia)* have been recognised to be potential candidates for restoration in other ecosystems. This is the case of *Baccharis dracunculifolia* (Asteraceae) in Brazil, a species that has colonising traits and presented a high percentage of germination, which makes it a potential candidate for forest rehabilitation (Gomes & Fernandes, 2002). In other research conducted inside Ernesto Tornquist Provincial Park in the southeast of Buenos Aires province, *Baccharis crispa* and the genus *Eryngium* were also identified as species with potential to be used in crop borders to preserve pollinators (Haedo, Stalldecker, & Marrero, 2017). Similarly, in southern Brazil, *E. Horridum* plays an important role in the maintenance of plant diversity in abandoned grasslands excluded from grazing and fire, since this rosette plant seems to facilitate the establishment of short forbs within the dense grass layer (Fidelis et al., 2008). In the study system *E. regnellii* is key to the maintenance of pollination mutualism, being a generalist species displaying a diverse assemblage of pollinators and presents high germination capacity along with other ecological attributes (Sabatino et al., 2015), which make it a potential species for restoring plant-pollinator interactions. Among the species that were well ranked for the IIR, *Lathryus pubescens* has other desirable attributes for revegetation projects, such as drought tolerance and nitrogen fixation, shared with some legume species (Douglas & Foote, 1985). In the same way, *Colletia paradoxa* presents root nodules that are nitrogen-fixing and capable of satisfying the nitrogen-needs of the host plant (Bond & Becking, 1982; Medan & Tortosa, 1976), which makes it a species with potential for soil conservation and remediation. Through the use of targeted planting species to attract and sustain pollinators, a range of ecological functions including pollination services could be successfully restored in degraded ecosystems or agricultural landscapes. In this way, the challenge is to integrate the research on pollination biology and plant restoration ecology to ensure sustainable pollination in restored ecosystems.

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