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Stewardship in Action

Land Stewardship and Protection of an Endangered Plant Species in an Insular World Biosphere Reserve

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ABSTRACT

Lotus eremiticus is an endemic species from La Palma World Biosphere Reserve. It has a small distribution range, low population size, and is threatened by introduced herbivores. Since these threats have not been removed from the protected area, they were excluded by building a fence. The land where the species grows is private property, so an agreement with the landowner was reached to permit measures to favor its recovery. During 2008–2019, as a result of this agreement and the conservation efforts, a large population increase occurred, from the initial 5 individuals to the 30 plants that are currently distributed at the original site. Furthermore, these measures allow the species to maintain stable population dynamics, meaning that this endangered species is itself capable of recovery if the threat is removed. This is a good example of how land stewardship is an effective tool to conserve endangered species.

Index terms: invasive herbivores; landowners; *Lotus eremiticus*; oceanic islands; recovery plan; stewardship; threatened species

Biosphere Reserves are recognized areas of representative environments that have been internationally designated within the framework of UNESCO's MAB Programme for their value to conservation, through providing the scientific knowledge, skills, and values to support sustainable development (Bridgewater and Cresswell 1998). La Palma (one of the Canary Islands, Spain) was entirely declared a World Biosphere Reserve in 2002 since it hosts a rich biodiversity at regional and national scales. More than 5434 terrestrial species (1056 of them endemic) have been listed in its territory (Martín et al. 2005a), including at least 879 vascular plant species (20% of them endemic to the island).

Habitat destruction and especially the introduction of invasive species are the most serious threats to the conservation of native species in the Canary Islands (Whittaker and Fernández-Palacios 2007). Introduced herbivorous mammals are the most important threat to the conservation of the endemic and threatened plant species (García-Casanova et al. 2001) and some of them such as goats (*Capra hircus*) and European rabbits (*Oryctolagus cuniculus*) are considered among the worst invasive species worldwide (Lowe et al. 2000). These destructive species, as well as domesticated (*Ovis aries*) and Barbary sheep (*Ammotragus lervia*) (Nogales et al. 2006) are currently affecting native plant species in La Palma World Biosphere Reserve (see Garzón-Machado et al. 2010; Irl et al. 2012).

A total of 366 species are considered as threatened in the Canary archipelago (Martín et al. 2005b), and 22 of them (15 plants) are present on La Palma (Martín et al. 2005a). One of these is *Lotus eremiticus* A. Santos (Fabaceae), a creeping perennial and hermaphroditic chamaephyte, with little development, thin branches, and small leaflets 1 cm long (Santos 1983) (Figure 1). Flowering is showy and abundant in the months of April and May. It shows self-compatibility; fruiting, which occurs July–August, is scarce but produces fertile seeds. More aspects of its reproductive biology are unknown, such as its pollinators, although the role of birds and reptiles as pollinators of the *Lotus* genus has been described (Ojeda et al. 2012; Siverio and Rodríguez-Rodríguez 2012). *L. eremiticus* is an endemic plant of La Palma and it is threatened by introduced herbivores (goats and rabbits), rats (*Rattus rattus*), and its low population and scarce distribution, formerly only five plants in one location (Medina and Hernández Martín 2015). For this reason, the species was included in the Spanish List of Endangered Species as in danger of extinction (IUCN category: Critically Endangered; Martín-Cáceres et al. 2011), and a recovery plan was approved by the Canary Islands Government and started in 2006. As a high-priority measure, this plan included increasing the current distribution of the species, as well as its number of individuals and populations, through reintroduction of plants obtained from seeds and cuttings collected from the natural population. Following the recommendations of the recovery plan, this action would be achieved by promoting legal action to acquire the properties where this endangered species is distributed. A second important objective, and taking into account that there are no other human impacts on the location besides uncontrolled livestock, was to reduce or eliminate herbivore pressure, thus improving the environmental conditions in the species' natural habitat.

Lotus eremiticus is located in only one place, Roque de la Viña, Don Pedro, Garafía (UTM: 28R 218720.35 N; 3193075.39 W; 300 m a.s.l.; Figure 2), inside a protected area classed as a strict nature reserve within Natura 2000 Net (IUCN category I). Vegetation is mainly composed of *Rhamnus crenulatae–Junipero canariensis* and *Myrico fayae–Ericetum arboreae* associations with rocky elements of *Greenovio–Aeonietea*. The main conservation

Figure 1.—Detail of the endemic endangered species *Lotus eremiticus*.

Figure 2.—Roque de la Viña, *locus classicus* of *Lotus eremiticus* in La Palma Island Biosphere Reserve.

objective of this protected area is to maintain the population of the species through reducing damage from introduced herbivores. Livestock grazing is prohibited in this protected area, but it was previously a traditional activity for centuries. Consequently, large numbers of free-ranging or feral goats and sheep are still present in the area, affecting this threatened species as well as other native plants.

Control or eradication of feral livestock is feasible on islands and an important tool for plant and environment conservation (Campbell and Donlan 2005). However, culling animal populations is an important source of conflict with animal rights associations that wish to prevent any animal suffering (Hutchins and Wemmer 1986). This ethical issue frequently hinders the approval of eradication campaigns by stakeholders and decision makers (see Lohr et al. 2014). As a result of this, no management plan or decision had been considered by the Island Council (Cabildo) to remove livestock from this protected area. So, to conserve this endangered plant species, the only possible solution was to install an exclosure fence to prevent the effects of herbivores. This has proved to be an effective measure in avoiding the extinction of endemic plant species (Garzón-Machado et al. 2010; Cogoni et al. 2013; Fenu et al. 2016), at least while control or eradication programs are being applied (Fenu et al. 2020).

Despite the location of *L. eremiticus* being inside a protected area, it is on private property. Current law allows the Island Council to implement conservation schemes based on the management plan of this protected area. However, to avoid conflicts with landowners, it was important to achieve their support for the conservation issues and measures involved in protecting this endangered species (Vickerman 1999; Olive and Raymond 2010). Nevertheless, in our case, the owners wanted to receive something in return because they had rented their properties to farmers and herdsmen as a place to obtain forage for their livestock. Furthermore, several years ago the landowners offered the Canary Government the chance to purchase the area, but a limited budget did not permit this, which is a common cause of failure in land acquisition (Wilcove and Chen 1998; Kamal et al. 2015). Taking into account the cost of buying this property, other ways to involve landowners in implementing management plans should be considered (Farmer et al. 2017). A range of incentives have been proposed to convince landowners to collaborate in land conservation and endangered species (Wilcove and Chen 1998; Vickerman 1999; Shogren et al. 2003; Kabii and Horwitz 2006; Kamal et al. 2015), including broad legal mechanisms such as conservation easements, covenants, or development agreements (Kabii and Horwitz 2006; Rissman et al. 2007; Ernst and Wallace 2008). However, there are few reports where stewardship options have been mentioned as a management option to conserve specific endangered species. This is probably due to landowners usually being unaware of endangered species on their properties (Olive and McCune 2017). Some specific projects have been carried out in the case of the Florida panther (*Felis concolor coryi*; Maehr 1990; Kreye and Pienaar 2015), the crested caracara (*Caracara cheriway*; Morrison and Humphrey 2001), or the Japanese murrelet (*Synthliboramphus wumizusume*; Hyde 2019).

From among the possible incentives, a rental agreement with the landowner was finally selected as the best solution to allow us to take appropriate decisions to protect this endangered plant species. Fortunately, the location of *L. eremiticus* is in a single property of about 12 ha belonging to just one person, which enormously facilitated the agreement. After several meetings with the owner and the participation of a conservationist neighbor who helped us to contact him, the lease agreement was signed in 2008 for a minimum of 5 y with the option to extend this or purchase. During 2014, the first lease was extended because the required budget for purchase was not approved. Unfortunately, the owner died that year and signing the second agreement was delayed until 2016 as his heirs resolved all the legal issues. However, they allowed us to continue with our conservation work on the property without an official agreement. Currently, the contract is valid until 2022 with a cost of 2200 Euros (approx. $2445 US) per year, meaning a total expenditure from 2008 to 2019 of 23,500 Euros ($26,119 US).

The agreement allows us to manage the property and fence the area surrounding where *L. eremiticus* is distributed, reaching an

approximate surface area of 0.55 ha. Once the impact of livestock was eliminated, we had to control the presence of rabbits and rats. To do this, three Tomahawk-type live traps were installed to capture the rabbits. After 4 wk without trapping any rabbits, and checking that there were no rabbit remains or signs inside, the fence traps were removed, and new damage by this species has not been subsequently observed. To minimize rat impact, which was periodically observed during the driest seasons in the area (summer), rat bait with second-generation anticoagulants (Difenacoum 0.005%) was employed, poisoning being one of the most common methods used to control this invasive species on islands (Duron et al. 2017).

As a result of these conservation measures, in the period between 2010 (completion of fence) and 2019 (end of first phase of the recovery plan), the natural population of *L. eremiticus* increased to 30 individuals, growing from the natural soil seedbank. In this same period, natural population dynamics were observed: a total of 89 plants had grown from the seedbank, but 62 died, probably due to the drought during those years. Another aim of the recovery plan was to reinforce the population. To do so, the total initial population (five individuals in only one location) was fortnight monitored by analyzing plant size and reproductive stage. This allows us to collect plant material (cuts and seeds), which were treated in greenhouse before their reintroduction in the same place and using substrate from the original location. Planting took place after rainfall in spring or autumn and providing water for a week during the next year to ensure the plants had taken root. Initial genetic analysis showed the species has a very low level of genetic variation (Pérez-Vargas et al. 2021), which allows us to maintain the original genetic set of the population along the recovery process. This process was carried out during this project on several occasions with a total of 228 cuttings obtained from the natural population. At the end of the recovery program (January 2019), a total of 77 *L. eremiticus* plants were counted inside the fence. Of these, 25 had grown directly from the soil seedbank, 28 were grown in the nursery greenhouse from seeds collected from naturally growing plants and reintroduced by transplanting them into the area, and 24 were reintroduced from cuttings grown in the natural area. An important successful result of this project was the natural regeneration of the *L. eremiticus* population originating from the reintroduced cuttings. Two new plants were still growing after 9 y, pointing to the capacity of this species to naturally regenerate its population if the main threat disappears.

New potential suitable sites for this species were defined throughout predictive analysis applying GIS (Geographical Information Systems) tools (Bermejo-Domínguez et al. 2007), which allow us to increase species distribution. The implementation of this agreement and the results obtained allowed us to establish another new land stewardship with the town council of Garafía, the municipality where *L. eremiticus* is found. Once they knew of the work done to favor recovery of this species and the suitable new place, the council decided to provide us a public property where a new population was introduced by the recovery plan team. In May 2017, 40 plants were introduced by local people involved in this project. After an initial 95% success, to date only 26 plants are still in the area. Plant care and attention has been provided by local people and environmental workers, always under technical supervision of the recovery plan technicians, as another example of how land stewardship helps to conserve native and endangered species (Ernst and Wallace 2008). Another example of the involvement of the local residents and neighbors in the conservation of this species took place in December 2018, when a landslide caused serious damage to the fence, allowing several goats to enter. A local farmer particularly fond of the plant and who wishes to conserve it (Ernst and Wallace 2008) because his aunt was the person who discovered this species in the 1950s, acted rapidly to remove three goats from inside the plot and partially repair the fence.

As an example of land stewardship, this agreement has been considered a fundamental tool during the project to preserve this endangered species: "*Lotus eremiticus* in La Palma World Biosphere Reserve." Moreover, it has been very useful to protect its habitat as well as other native and protected plant species present in the same area, although this project was not foreseen or run as a multispecies recovery plan (Langpap and Kerkvliet 2012). Talking to local residents, neighbors, and landowners provides important information for making appropriate management decisions (Henderson et al. 2014). Promoting environmental conservation through educational programs is also considered a basic instrument to engage landowners and other citizens, to gain their support in stewardship activities (Farmer et al. 2017).

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