



Photo: Jacintha Castora Photography

## Native gardens for Galapagos – can community action help to prevent future plant invasions?

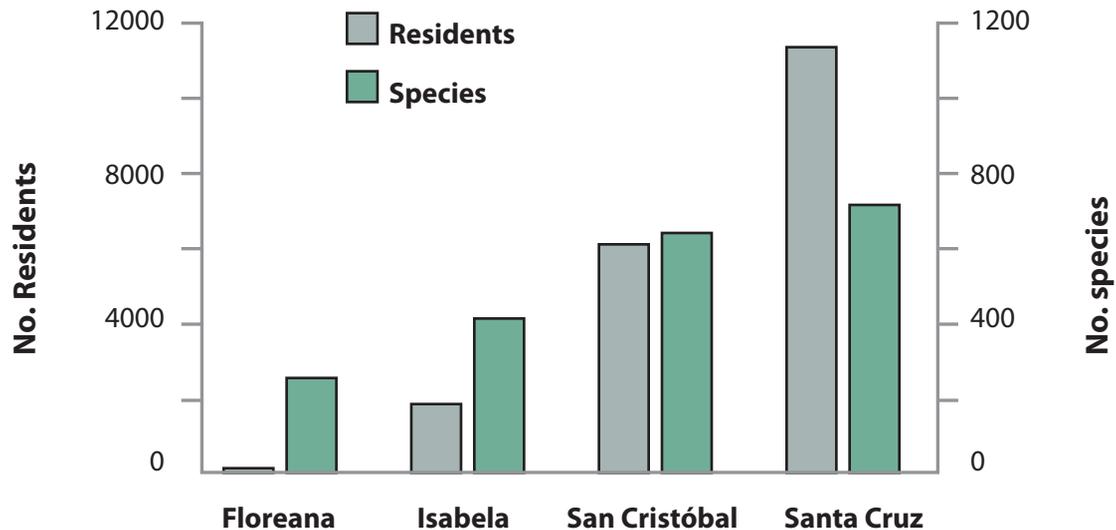
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### Introduction

Introduced species present the greatest threat to the unique terrestrial biodiversity of the Galapagos Islands. Analysis of data from a survey of 97% of all properties in the four inhabited islands (Floreana, Isabela, Santa Cruz, and San Cristóbal), carried out between 2002 and 2007, combined with information from the Charles Darwin Foundation (CDF) herbarium (2009), show that there are now 870 recorded alien plant species in the archipelago. Of these species at least 26% (229 species) have now naturalized (established and reproducing without help from humans) and 131 species are already invading natural areas in the archipelago (Guézou and Trueman, 2009).

The total number of alien plant species on each island is directly related to human population size, with Santa Cruz and San Cristóbal having the greatest number of species (Figure 1). However, most of these species occur in very few properties (92 species occur in only one property, 229 in less than 20), indicating recent introduction to the archipelago, probably within the last 30 years. It has been noted in the literature that most plant species take more than 50 years to become abundant and up to 150 years to naturalize (Sullivan *et al.*, 2004; Caley *et al.*, 2008). This means that it is probable that many of these species will naturalize and become invasive in the near future, as the propagation of introduced species increases alongside human population growth.



**Figure 1.** The total number of residents and alien plant species on each of the four inhabited islands.

Galapagos already has a quarantine system that prohibits all non-permitted plants from being brought to the archipelago. However, as explained above, new plant invasions will occur from those alien species already present. Therefore, active management within the archipelago is needed to reduce the spread of these potential invaders. In order to respond to this need, two solutions have been tested in Galapagos. The first was to eradicate species with limited distributions that posed significant threats to Galapagos in the future; the second focused on community awareness and action through a native gardening program. This paper provides a brief summary of the eradication efforts and then reports on progress of the native gardens program over the last three years, providing baseline data for monitoring the impact of this strategy.

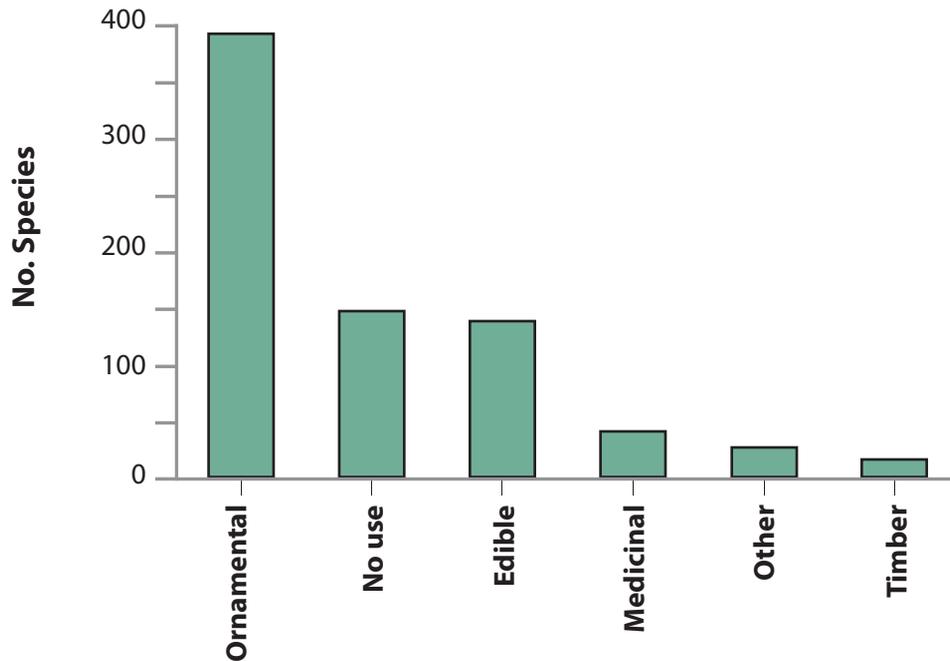
### Eradication efforts

The theoretically simple solution of completely eradicating species from individual islands (Harris and Timmins, 2002) proved to be far more difficult than expected due to the social complexities associated with introduced species removal on private land. In a pilot study of 30 plant eradication projects covering 23 species, carried out between 2001 and 2007 by CDF, only five were successful. Of the 25 unsuccessful projects, reasons for failure varied. One failed due to technical difficulty, three because of the biology of the target plants, six because the projects were too ambitious (the species had unexpectedly large distributions when detailed maps were made), ten

because of lack of long-term funding after the trial finished, and six due to individual land owners not allowing the work to be completed on their land (Gardener *et al.*, 2010). The reasons for denying permission for species removal were varied, and included the active or perceived use of some species for medicine, as an ornamental, for timber, or due to sentimental attachment. In addition, several land owners denied access to their land because of worry over the integrity of the field team.

However, a targeted project in 2007-8 that focused on removal and replacement of the invasive *Leucaena leucocephala* from private gardens in Puerto Ayora proved more successful. Each of the 27 land owners with *L. leucocephala* on their land was provided with information about the species, already known to be aggressively invasive in the coastal village in San Cristóbal. If they agreed to allow removal of the species, they were offered the choice of several different natives as replacement. Although repeated visits were necessary for some of the land owners, everyone finally agreed to participate in this project and a total of 292 plants were killed (using herbicide or removed manually). All of the land owners continue to remove new seedlings from their properties. These experiences indicate that eradications may be a possible solution for plants that are currently rare, if carried out in tight partnership with the community.

As the majority of the alien plant species in Galapagos are ornamentals (Guézou and Trueman, 2009; Figure 2), minimizing the risk from this group of species is an important step in preventing future problems. To address this, a program to encourage the use



**Figure 2.** The different uses associated with alien plant species in Galapagos.

of native and endemic plants in gardens and public spaces in Galapagos began in 2007. This approach has proven more successful than the trial eradication programs discussed above (Atkinson, 2008).

### The native garden initiative

The native garden initiative is not a new one for Galapagos. Nurseries have been producing native plants on several of the inhabited islands for over a decade, with the aim of increasing awareness of the native flora. However, the realization that many of the alien ornamentals could become problems in the near future was made only recently and provided a new energy to the initiative.

The CDF has two nurseries in Santa Cruz, one in the highlands and one in the lowlands. While the nurseries have been producing plants for the community for the last decade, the native garden project began in earnest in 2007. In 2008, CDF also reinitiated the project in the coastal village of Puerto Baquerizo Moreno in San Cristóbal. The project has also begun in Floreana, with the establishment of a small nursery in the highlands that was scheduled to open in early 2010. The Galapagos National Park Service in Isabela has a long history of gardening with natives in the village of Puerto Villamil, and still maintains a small active nursery on the island.

Data in this report come from the nurseries managed by CDF in San Cristóbal and Santa Cruz.

### Santa Cruz

Data from 2007 to 2009 show a steady increase in the number of clients becoming involved in the project. In 2009, 173 different clients were provided with 7712 plants of 47 species (Table 1). Over the last two years, the gardening team has provided plants for about 200 projects, most of which have been for private gardens, although businesses, educational establishments, and public and private institutions have also become involved in the initiative (Figure 3). In addition, the gardening team has carried out landscaping projects for over 30 different clients. This includes an ambitious project for a housing development carried out in the highlands of Santa Cruz, where all of the grounds were landscaped with native species; hence the very high plant production in 2008.

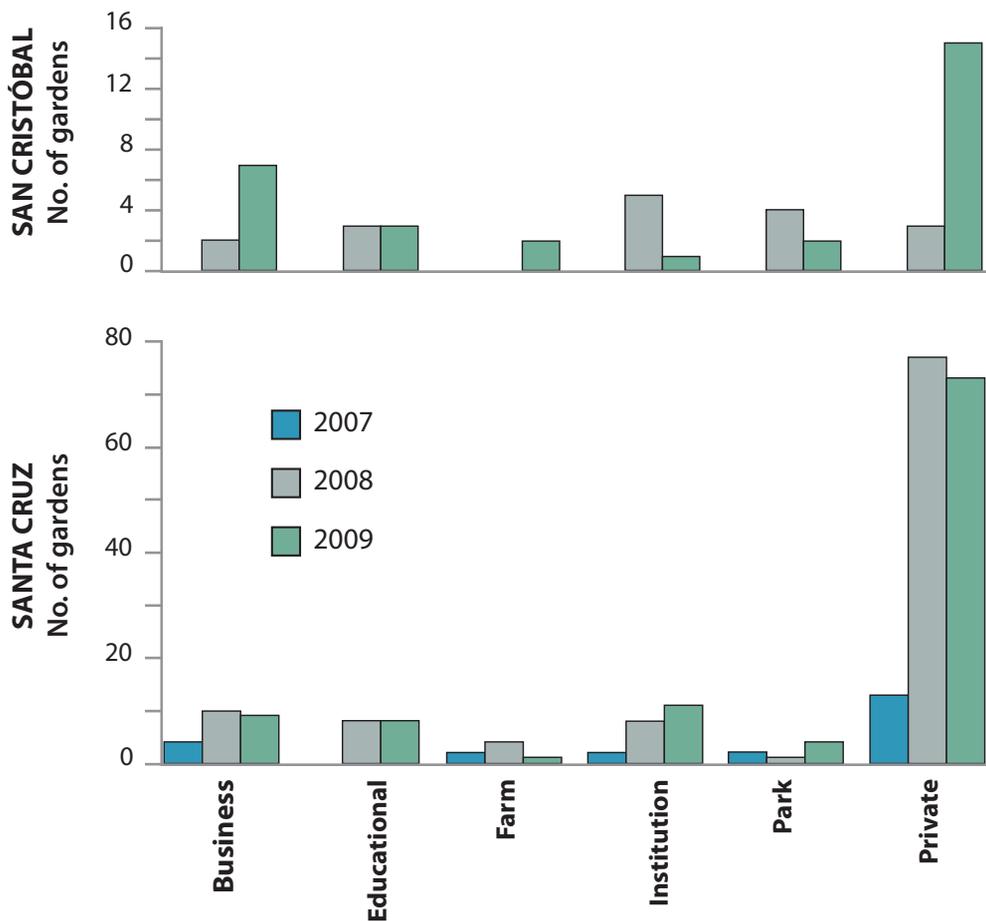
### San Cristóbal

Over the last two years the project in San Cristóbal has grown considerably since its beginning in 2008. In 2009, the nursery produced 2618 plants of 48 species for 44 different clients, compared to 797 plants of 32 species in 2008 (Table 1). In addition, the team created 28 gardens, which represents an increase of 160% compared to 2008. Most of these were private gardens for houses in the village, but several restaurants and hotels also became involved in the project (Figure 3).

In addition, in 2009, the project started to work with theme that has received many requests from farmers plants for reforestation projects in the highlands – a there.

**Table 1.** Number of clients, type of activity (native garden or reforestation), number of species, and number of plants produced in CDF’s native plant program on San Cristóbal (2008-9) and Santa Cruz (2007-9).

Island	Item	2007	2008	2009
San Cristóbal	Total number of clients		14	44
	A. Native gardens		14	41
	B. Reforestation		1	3
	Number of species		32	48
	Number of plants produced		797	2 618
Santa Cruz	Total number of clients	30	129	173
	A. Native gardens	28	128	169
	B. Reforestation	2	1	4
	Number of species	24	57	47
	Number of plants produced	1 243	11 403	7 712



**Figure 3.** The types of projects for which plants were provided in Santa Cruz and San Cristóbal.



Photo: Anne Guezou

## Conclusions and recommendations

While still in its infancy, the native gardens project represents an important initiative in the sustainable development of Galapagos. The data presented in this study provide a useful baseline to measure future growth of the gardening project. However, they do not directly show the impact of this project on limiting the use or spread of introduced alien species. In order to do this it is necessary to return to a subset of properties and carry out a new inventory of introduced plant species, in addition to interviewing the land owners for their reasons for changing their gardens. In this way the direct impact of the project can be assessed.

Galapagos hotels and institutions are recorded as having the highest diversity of alien species in their gardens (Trueman *et al.*, submitted) and represent an important focus for future work. This will be helped by a bold initiative from the Ministry of Tourism to increase environmental responsibility by hotels and

restaurants in Galapagos through compliance to a series of standards, including the use of native species for landscaping.

An essential component to solving invasive species problems worldwide is through the support of the community. The increased awareness and knowledge of the native flora of Galapagos generated through the gardening project and its associated education project (e.g., Atkinson *et al.*, 2009) are important and positive steps to help people realize that simple actions by each and every resident can help in the conservation of the archipelago.