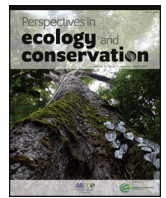




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Research Letters

Mapping opportunities for environmental education in a defaunated landscape

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ABSTRACT

Due to historical defaunation and extensive land-use changes, central Chile lacks a megafaunal flagship species with which to attract attention to conservation of the region. We compare the ease of observing potential flagship species according to their distributions in the landscape, and the practical barriers to promoting nature tourism focused on those species, in those locations. First, we consider the distributions of a previously identified flagship fleet for nature engagement in central Chile, consisting of small animals and trees. Second, we map potential areas for the reintroduction or conservation of the guanaco (*Lama guanicoe*), previously identified as a potential phoenix flagship for central Chile, and the puma (*Puma concolor*), a native felid appreciated by global audiences. All the areas identified where flagship species are currently found, or could be reintroduced, are fragmented and show almost no overlap with existing protected areas. We conclude that there are fewest practical barriers to encouraging flagship observation in the flagship fleet species areas, compared to the phoenix flagship and the felid flagship options. We discuss opportunities for private protected area creation, nature tourism, and outreach programs promoting observation of the flagship fleet in these areas.

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Introduction

Animals, plants, and other species have many different roles, including symbolic roles, within human cultures, which affect how those species are treated in daily life (Descola, 2005). The conservation flagship approach attempts to build on this by promoting species and their representations as symbols of conservation programs. Empathy and the sensual and affective salience of other species to humans (their “charisma”) also produces engagements with nature and conservation (Lorimer, 2007). Species familiarity is also associated with cultural significance (Correia et al., 2016). Flagship species thus attempt to present well-known species in ways that elicit empathy and charisma to attract attention to and promote engagement with conservation. However, the identification of which species should be used as flagship species is complex (Barua et al., 2011), and to some degree arbitrary due to the con-

tinuum of degrees of interest and forms of interaction between humans and other species.

Distance also affects types of engagements with flagships, and flagship efficacy. For example, the successful annual UK fundraising event Elephant Parade in support of elephant conservation in situ in India uses elephant representations that “work” in a UK context, although these are unrelated to local Indian representations and engagements (Jepson et al., 2011). By contrast, some well-known flagships, such as the polar bear as a representation of the perils of climate change, fail to motivate behavior change in people for whom the flagship and issue seem remote from their daily lives (Slocum, 2004). Thus, elephant flagship representations successfully attract support for conservation of distant animals, while polar bear flagship representations have failed to do so, illustrating the mixed track record of attracting attention to the conservation of distant species not directly observed or experienced by the target audience. The possibility of direct engagements with flagship species is expected to play a role in creating certain types of relations to conservation and nature, e.g. with the places, habitats and landscapes where flagship species live.

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The central, Mediterranean-climate zone of Chile is a hotspot of endemic plant and animal species (Simonetti, 1999). However, the low valuation of central Chilean landscapes by Chilean society, which is regarded as empty and lacking wild animals, translates into a lack of conservation effort (Root-Bernstein and Armesto, 2013; Root-Bernstein, 2014; Lindon and Root-Bernstein, 2015). In fact, it is the species and landscapes in the most remote parts of Chile that are best known and liked (Lindon and Root-Bernstein, 2015). This partly reflects a preference for creating protected areas in uninhabited scenic areas. It can also be accounted for by the cultural and political history of central Chile, where an erasure of landscapes and their human and non-human inhabitants has facilitated colonialism and industrial exploitation (Root-Bernstein, 2014).

To bring the endemic and native species of central Chile and their habitats more into the public imagination, with the aim of promoting conservation awareness and environmental education, a flagship “fleet” or group of eight known and liked animals and plants has been developed (Supplementary Material; Root-Bernstein and Armesto, 2013). However, convincing the wider public that these species inhabit landscapes perceived to be barren is a challenge. The goal that we address here is how to link conservation symbolism with personal experience in nature, for the promotion of conservation of habitats and landscapes of central Chile (Folmer et al., 2013).

The approach of designing a fleet of multiple flagship species was intended to compensate for the lack of a single charismatic megafaunal flagship candidate for the region (Root-Bernstein and Armesto, 2013). Targeted questionnaires, interviews and action-participation carried out in central Chile confirmed the lack of a single culturally significant charismatic large species and also formed the basis for selecting the best-known and appreciated species typical of the region (Root-Bernstein and Armesto, 2013; Root-Bernstein, 2014). Land-use changes and hunting since the colonial period have resulted in defaunation in central Chile (Armesto et al., 2010). Consequently, the flagship fleet species are relatively small and not highly abundant and visible. The flagship fleet is designed to appeal to a specific set of ways of interacting with the environment, e.g. collecting of observations, valuing auto-didactic learning, or enjoying subtle poetic or spiritual experiences, all of which are valued in Chilean society.

A second approach to filling the large charismatic flagship species gap is to consider reintroducing such species. Species reintroductions need to consider a wide range of factors, including the original causes of species loss and whether those have been controlled; local stakeholder support; existence of suitable habitat for the species to be reintroduced that is large enough for a self-sustaining population; the genetic origins of the reintroduced individuals; and welfare and survivorship during and after release (IUCN/SSC, 2013). Here we consider the possible flagship benefits of two large symbolic candidate species that have been proposed or recommended as conservation flagship species relevant to central Chile.

Two species that could be reintroduced, protected or rewilded to improve public perceptions of biodiversity are guanaco (*Lama guanicoe*) and puma (*Puma concolor*). The guanaco's reintroduction to central Chile as a phoenix flagship, or reintroduced species used to promote conservation, is supported by Chilean urban dwellers (Lindon and Root-Bernstein, 2015). Regionally appropriate models for its reintroduction have been proposed (Root-Bernstein et al., 2016). Global assessments show that wild felids are widely appreciated species, and thus they have been recommended as flagships to promote conservation around the world (MacDonald et al., 2015). This recommendation has been made in spite of the fact that in local contexts, including the Chilean one, they are often implicated in human-wildlife conflict (Herrmann

et al., 2013). If they could be reintroduced and protected under suitable conditions, both species have been predicted to have strong symbolic power.

The guanaco, puma and flagship fleet are not mutually exclusive flagships and could all be used to promote environmental education and conservation awareness in central Chile. However, it is clearly more difficult to carry out a reintroduction and conservation program than to simply promote existing, if hard to find, species. We thus ask how much area there is, and how it is distributed, where one can see all of the flagship fleet, compared to the area available for guanaco and puma reintroduction. The size and spatial distribution of areas where flagships can be experienced by their audiences will contribute to whether they seem remote and irrelevant, or engaging and present in central Chilean landscapes. We assessed where the maximum number of flagship fleet species are concentrated and thus potentially observable. These areas would be high priority suitable sites for nature tourism and environmental education activities. Next, we mapped habitat where puma and guanacos could be reintroduced. We discuss the possibilities for linking flagship symbolism to nature experience in each set of identified areas.

Materials and methods

Our study area included the administrative regions of Coquimbo, Valparaíso, Region Metropolitana, Bernardo O'Higgins and El Maule, being the administrative regions corresponding to central Chile, and including principal cities and towns (e.g. Santiago, Rancagua, Valparaíso, Viña del Mar, San Fernando, Curicó, Talca, Linares) from which the target public, urban nature tourists, could be drawn.

The species distributions were obtained from the most up to date available layer sources. *Lycalopex culpeus*, *Pteroptochos megapoidius*, *Athene cunicularia*, *Calopistes palluma* polygon layers were obtained from Marquet et al. (2004) at various scales depending on the scales of the original bibliographic sources, including reports of presence and maps, from which they were obtained. *Octodon degu* polygon distribution was obtained from Nature Server (Patterson et al., 2005), at 1:1,000,000 scale. Tree species distributions (*Lithrea caustica* and *Acacia caven*) were extracted from vector layers at 1:50,000 scale from the most complete vegetation and land cover classes map for Chile provided by the Chilean Forestry Services Database at 1:50,000 resolution. We were not able to find distribution maps for the tarantula *Grammostola mollicoma*, so we excluded this flagship species from analysis. We identified areas where the distributions of all 7 species overlapped using vector overlay of the polygons. Polygons drawn at large scales are likely to include some spaces that are errors of commission: the species are not really present within the whole polygon. Thus, using the 1:50,000 scale from the tree data to determine overlaps should reduce errors of commission. Furthermore, both the tree and the animal species are typical of semi-open habitats such as matorral, espinal, and successional or patchy habitats. Thus, it is unlikely that areas where the two tree species are found are actually “vacant” areas within the animal species polygons where they are never found or cannot occupy.

In identifying areas with maximum species overlap (7 out of 7 species), we weighted the importance of each species equally. The original study (Root-Bernstein and Armesto, 2013) indicated that the species should be presented as a set to facilitate a narrative-based environmental education strategy based on how the species interact. Furthermore, we have no data to indicate whether some of the flagship fleet species are more preferred by particular audiences (Root-Bernstein and Armesto, 2013). We checked whether the 7-species overlapped area coincided with protected areas. National protected area boundaries were obtained from the World

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