Global Ecology and Conservation 2 (2014) 277–288

Contents lists available at ScienceDirect

Global Ecology and Conservation

journal homepage: www.elsevier.com/locate/gecco

Original research article

Small mammals as indicators of cryptic plant species diversity in the central Chilean plant endemicity hotspot

Meredith Root-Bernstein [a,*], Magdalena Bennett [b], Juan J. Armesto [a], Luis A. Ebensperger [a]

[a] Departamento de Ecología, Facultad de Ciencias Biológicas, Pontificia Universidad Católica de Chile, Santiago, Chile
[b] Wildlife Conservation Research Unit, Zoology Department, University of Oxford, Tubney House, Tubney OX13 5QL, UK

ARTICLE INFO

Article history:
Received 15 May 2014
Received in revised form 7 October 2014
Accepted 9 October 2014
Available online 23 October 2014

Keywords:
Cryptic species
Diversity
Endemic
Indicator species
Octodon degus
Plant

ABSTRACT

Indicator species could help to compensate for a shortfall of knowledge about the diversity and distributions of undersampled and cryptic species. This paper provides background knowledge about the ecological interactions that affect and are affected by herbaceous diversity in central Chile, as part of the indicator species selection process. We focus on the ecosystem engineering role of small mammals, primarily the degu *Octodon degus*. We also consider the interacting effects of shrubs, trees, avian activity, livestock, slope, and soil quality on herbaceous communities in central Chile. We sampled herbaceous diversity on a private landholding characterized by a mosaic of savanna, grassland and matorral, across a range of degu disturbance intensities. We find that the strongest factors affecting endemic herbaceous diversity are density of degu runways, shrub cover and avian activity. Our results show that the degu, a charismatic and easily identifiable and countable species, could be used as an indicator species to aid potential conservation actions such as private protected area uptake. We map areas in central Chile where degus may indicate endemic plant diversity. This area is larger than expected, and suggests that significant areas of endemic plant communities may still exist, and should be identified and protected.

1. Introduction

Central Chile is recognized as a region of globally significant rates of plant endemicity and significant habitat loss (Schulz et al., 2010; Myers et al., 2000). The distribution and locations of endemic floral communities, and their association with habitat management approaches, are largely unknown (Figueroa et al., 2011, 2004; Rovito et al., 2004). Shortfalls in sampling of endemic plant distributions and lack of identification expertise are barriers to implementation of appropriate conservation actions in this region (e.g. Rovito et al., 2004). To enhance conservation in central Chile (see Root-Bernstein and Armesto, 2013; Root-Bernstein and Jaksic, 2013), we explored whether presence of degus can be used to identify areas of high floral diversity in central Chile's mediterranean climate region.

Small mammal activity is often associated with herbaceous plant diversity and in many cases has been shown to cause diversity increases. For example, herbaceous diversity is higher inside compared to outside the colonies of pikas (*Ochotona curzoniae*) and voles (*Alticola stoliczkanus*) (Bagchi et al., 2006). Rabbits (*Oryctolagus cuniculus*) create key germination sites through disturbances (Bakker and Olff, 2003), and pocket gopher (*Thomomys mazama*) mounds create small-scale species

* Correspondence to: Bioscience Department, Aarhus University, 8000 Aarhus, Denmark. Tel.: +44 1865 285525.
E-mail address: meredith.root-bernstein@ouce.ox.ac.uk (M. Root-Bernstein).

http://dx.doi.org/10.1016/j.gecco.2014.10.006

heterogeneity in meadows (Jones et al., 2008). Small mammal activities such as grazing, trampling, and digging can alter herbaceous plant community composition (Davidson et al., 2012; Root-Bernstein and Ebensperger, 2013) via reduction in plant–plant competition (e.g. by opening colonizable space) and decrease in abiotic limitations (e.g. via nutrient input, water retention) (Kerley et al., 2004; Olff and Ritchie, 1998; Root-Bernstein, 2013; Wright and Jones, 2004). Whether these effects are net positive or negative is currently difficult to predict due to interactions between multiple variables (Root-Bernstein and Ebensperger, 2013). Thus, though some small mammals may be associated with high herbaceous plant diversity, this must be assessed individually for each mammal species, in each community in its range, and under the range of relevant abiotic conditions (Bakker et al., 2009, 2006; Root-Bernstein and Ebensperger, 2013). Where small mammals that make disturbances are associated with positive effects on plant diversity, they and their disturbances (burrows, mounds or runways) could make easily detectible indicators of diverse plant communities.

The distributions of vertebrates are better known in Chile than those of plants (e.g. Tognelli et al., 2008), and would be feasible to monitor as indicators either through scientific surveys or collection of local ecological knowledge. However, the use of vertebrate species as compositional indicators of biodiversity has been critiqued (Carignan and Villard, 2002; Landres et al., 1988). Landres et al. (1988) recommend seven criteria that should be met in order to use vertebrates as indicator species. They recommend that vertebrate species be developed as indicators only when (1) goals are clear, (2) direct measurement of management variables is not possible, (3) selection criteria are explicit, (4) all selected species are used, (5) biology of the indicator is known in detail, with research carried out to determine how it affects or is affected by the environment, (6) subjectivity is recognized, and (7) the selection process is reviewed. Selecting indicators that detect diversity at appropriate management scales is also important (Carignan and Villard, 2002).

Here, we address Landres et al.'s (1988) criterion (5), that the ecological interactions of the potential indicator species with its environment be well characterized and understood. We do so by investigating the relationship of native herbaceous plant diversity to the degu (*Octodon degus*), an endemic, non-threatened social rodent of central Chile (Patterson et al., 2007) known to favor certain plant populations and to have ecosystem engineering effects (Madrigal et al., 2011; Olivares and Gastó, 1971; Root-Bernstein et al., 2013). The relationship between degu disturbance activities and the herbaceous community composition and diversity in central Chile has not been studied previously. We address this gap in order to assess the degu's suitability as an indicator of hard to recognize and little known, thus "cryptic" communities (*sensu* Pitt et al., 2012), of high plant diversity and high rates of endemicity to central Chile.

2. Material and methods

2.1. Study site and species

The study took place at the Estación Experimental Rinconada de Maipú (33°23′ S, 70°31′ W, altitude 495 m), an agronomical field station owned by the Universidad de Chile, Santiago, Chile. Our study site encompassed a mosaic of espinal (*Acacia caven* savanna), open grasslands, and matorral (evergreen shrubland). This area is stocked at 0.92 sheep equivalents per ha over 898 ha. Dominant woody species in shrublands are *Lithrea caustica*, *Baccharis marginales* (evergreens) and *Acacia caven* and *Proustia pungens* (drought resistant, deciduous species).

Degus (*Octodon degus*) live in burrows forming colonies >10000 m^2 that can last for at least a decade (Ebensperger et al., 2011). Burrows used by different social groups are connected aboveground by well-marked runways forming a network between all burrow openings across the landscape.

We take advantage of natural variation in degu disturbance densities to draw logical conclusions about degu effects on the plant community (Cleland, 2001; Rothman and Greenland, 2005). It is unlikely that degus selectively associate with factors that are themselves the direct or principal causes of significant changes in plant diversity. A recent multiple year study did not find any variables, including adjacent herbaceous cover or quality, that predicted burrow occupancy (Ebensperger et al., 2011). New burrows are formed primarily at the edges of the colony as it expands, with new runways forming only to connect new burrows or to reconnect burrows that have been abandoned for several years. Degus are generalist herbivores and forage along or near runways (Root-Bernstein and Ebensperger, accepted). Distinct plant community patches are sometimes clearly confined to the area within a runway (see Fig. 1). Inductively, this set of evidence strongly suggests that runway creation and uses cause changes in plant communities. Comparatively, degu colony patterns and dynamics appear to be very similar to those of prairie dogs, a species with a functionally equivalent niche (Davidson et al., 2012; Whicker and Detling, 1988). Changes in vegetation on prairie dog colonies are due to prairie dog herbivory and disturbance activities (Archer et al., 1987; Garrett et al., 1982).

2.1.1. Plot selection and characteristics

Twenty plots of 10 m $\times$ 10 m were set up in June 2010 along the south facing slopes and adjacent plain of an extension of the coastal range (495 masl). We selected plots according to the degu runway and burrow densities, spaced at least 100 m from one another, using stratified random sampling (see Table 1). While our stratification with the lowest level of degu activity has zero burrows, we were not able to find a set of comparable habitat sites with no degu runways at all, due to the high abundance of degus and large extent of the colony.