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The efficiency of two widely used commercial live-traps to develop monitoring protocols for small mammal biodiversity

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ABSTRACT

Biodiversity monitoring programs have been implemented worldwide as a source of information on ecosystem functioning. However, controversy concerning the indicators that should be monitored, and the development of adequate monitoring protocols for multi-species communities still hamper such implementation, especially in the case of small mammals. We analyze differences in the efficiency of the two most widely used commercial traps (Longworth and Sherman) working simultaneously in eight different mountain habitats in Andorra country (NE Iberia) as a first step for establishing standardized sampling protocols for species-rich small mammal communities. From summer 2008 to fall 2010 (six sampling occasions) we captured a total of 728 small mammal individuals (1445 including recaptures) of 13 species (12 in Longworth and 11 in Sherman, 10 species shared). Despite some specific biases (underestimation of two large species by Longworth traps and underestimation of one small species by Sherman traps), estimates of community parameters and similarity indexes, sampling efficiency (number of small mammals trapped), detectability, mean weight, and sex-ratio of the most abundant species, were similar for both sampling methods. Our results suggested that both trap models could be used interchangeably – without relevant biases – in small mammal community assessments where large species are infrequent. Focussing monitoring programs on highly detectable small mammal species (common species) would allow the establishment of robust monitoring programs aimed at reducing the time invested and economic costs.

1. Introduction

Biodiversity monitoring programs have been implemented worldwide as a source of information on ecosystems functioning, as well as to evaluate whether conservation policies are delivering their expected goals (EEA, 2010, 2012). Systems of indicators have been developed in parallel to policies (Bubb et al., 2010), and standardized robust sampling techniques and bioindicators of environmental change have been developed for a variety of focal groups (i.e., birds and butterflies, Herrando et al., 2015), following appropriate applied research (e.g. Voříšek et al., 2010 for birds).

Nevertheless, discrepancies among indicators that should be monitored and the development of monitoring protocols still exist (EEA, 2012; Diaz et al., 2015; Gao et al., 2015), especially for the focal groups most difficult to sample in field conditions (Overmars et al., 2014). This is usually the case of mammals in general and small mammals in particular. Beyond any statutory obligation of monitoring population changes (Harris and Yalden, 2004), mammal monitoring allows the quantifying of impacts associated with anthropogenic environmental change (i.e. climate and landscape change), informing conservation and management priorities (Flowerdew et al., 2004; Wright et al., 2014). Besides, there is increasing evidence that landscape and climate change is affecting the composition of small mammal communities, especially in the Mediterranean region (Szpunar et al., 2008; Torre et al., 2015). In fact, long-term single-species monitoring of target small mammals such as lemmings *Lemus* spp. and voles *Microtus* spp., *Myodes* spp. have settled the ground for understanding how and why climate, food availability, habitat structure, predation and disease interact to regulate animal populations (see Stenseth, 1999; Ims et al., 2008 for reviews).

Monitoring small mammal biodiversity change in addition to population change is hampered by the lack of "universal" sampling protocols (and bioindicators) that preclude the application of standardized monitoring programs. For instance, most programs for small mammal monitoring established in the UK were short in time (<15 years, Flowerdew et al., 2004) and/or narrow in space (i.e.

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long-term monitoring but for single places, Newman et al., 2003), mostly due to methodological and logistic constraints. Further, all these surveys were based on live-trapping methods (Sibbald et al., 2006), using single types of live traps while aiming at monitoring several species of small mammals (Flowerdew et al., 2004). Longworth traps are recommended and used in many European cold and temperate sites (Flowerdew et al., 2004), whereas Sherman traps are the most commonly used traps in North America (Slade et al., 1993), being routinely used for long term single-species monitoring programs (Previtali et al., 2009). However, estimating small mammal community composition and structure by using single live-trapping methods can be unrealistic due to trap-specific differences in trappability among species (Anthony et al., 2005; Cáceres et al., 2011; Dos Santos-Filho et al., 2006; Lambert et al., 2005) and even among sexes, sizes or ages within species (Burger et al., 2009). Thus, several authors suggest using a combination of sampling techniques to account for trappability differences (Fonturbel, 2010), to restrict monitoring to the most trapped species (Solari et al., 2002), or to estimate detectability and correct for its effects (Mackenzie et al., 2002).

Recently, we established a small mammal monitoring program in Spain (SEguimiento de MIcromamíferos Comunes de España, SEMICE, Torre et al., 2011) partially inspired by UK small mammal monitoring programs. We focused on common species easy to catch with commercial live traps. We here test differences in the efficiency of the two most widely used commercial traps (Longworth and Sherman) working simultaneously in eight different mountain habitats, as a first step for establishing standardized small mammal sampling protocols. Specifically, we test differences among species and within-species trappability, as well as trap-induced mortality of the most common species. In this way, we ascertained whether biases may be present when small mammal communities are sampled and estimated by both methods working altogether.

2. Materials and methods

2.1. Study area

Field work was carried out in the Principality of Andorra, located on the eastern side of the axial Pyrenees (Fig. 1). Despite its small size (468 km^2), Andorra is a country of strong contrasts due to its rugged terrain with an average height above 2000 m a.s.l., (840–2946 m). Three main vegetation belts can be delimited depending on elevation and orientation (Folch, 1984): the montane zone (800–1700 m), the subalpine zone (1700–2400 m), and the alpine zone (beyond 2400 m). Forests cover 43% of the area, being Black pine (*Pinus uncinata*) and Scots pine (*Pinus sylvestris*) the most frequent tree species (Folch, 1984). Grasslands occupy 30% of the territory, and shrublands 8%, including siliceous alpenrose (*Rhododendron ferrugineum*) and juniper-dominated (*Juniperus communis*) scrub. Rock and scree areas occupy 15% of the territory, and synanthropic environments, such as farming and residential areas, less than 5%, although human influences are evident throughout the country.

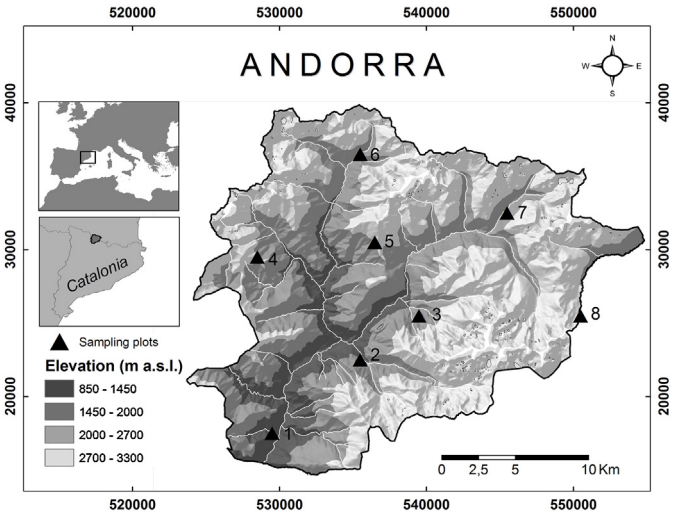

Fig. 1. Map showing the location of the study area and the sampling plots according to elevation. See methods for the meaning of plot numbers.

2.2. Small mammal sampling

Sampling was performed in 2008 to fall 2010 on eight plots during six trapping sessions of three days each (two sessions per year, July and October), collectively lasting 18 days. Every plot was sampled by a 6 × 6 trapping grid, consisting of 18 Sherman traps (Sherman folding small animal trap; 23 × 7.5 × 9 cm; Sherman Co., USA) and 18 Longworth traps (Penlon Ltd., Oxford, UK), alternated in position (Cáceres et al., 2011; Nicolas and Colyn, 2006), spaced 15 m apart, and brought into operation for three consecutive nights. Traps were arranged singly rather than in pairs as no trap saturation was expected on the basis of the usual low density of small mammals in the study areas (authors unpub.). Traps were set in the evening of the first day, and checked on five occasions (the early morning of the first, second and third day, and the night of the second and third days). So, every trapping session (primary sampling occasion) consisted in five sampling occasions (secondary sampling occasions), collectively lasting 30 sampling occasions.

Traps were baited and re-baited when necessary (when the bait was eaten) with a piece of apple and a mixture of tuna, flour and oil. This bait was proven to be effective for rodents and shrews at least in Mediterranean mountain conditions (e.g. Torre et al., 2007; Torre et al., 2014a). Traps were insulated by including hydrophobic cotton for bedding. The small mammals caught were identified to species, sexed, marked (rodents with ear tags – National Band Co. USA – and shrews with fur clips), and released at the point of capture (Gurnell and Flowerdew, 2006). All the sampling procedures met the ASM care & use guidelines (Sikes et al., 2011). We used counts (e.g. the number of different individuals trapped within the three days, Morris, 1996) as an estimate of population size in each study plot, assuming that the unseen proportion of the population is constant and that counts and estimates would have yielded similar results (Slade and Blair, 2000).

The eight sampling stations were distributed along a strong elevation gradient (1060–2255 m a.s.l.) within the three vegetation/climatic domains. Three plots were situated on the montane domain (1 – *Quercus pubescens* and 2 – *Pinus sylvestris* forests, and 3 – a meadow site), four on the subalpine domain (4 – *Abies alba* and 5 – *Pinus uncinata* forests and 6 – a scree and 7 – a meadow site), and one in the alpine domain (8 – scree). Plots were established in sites as heterogeneous as possible (e.g. including clearing in forests and shrubs in meadows and scree) in order to capture all species present.

2.3. Data analysis

The variables for comparison among trap types were community parameters (species diversity and similarity), species' abundances and biomass, species' occupancy, detectability and mortality, and sex-related within-species differences. This wide range of relevant variables to compare among trap types required the development of multiple analytical strategies summarized in the Appendix. First, a matrix with the number of individuals of the small mammal species by sampling method was created, and