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Urban dogs in rural areas: Human-mediated movement defines dog populations in southern Chile

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ABSTRACT

Management strategies for dog populations and their diseases include reproductive control, euthanasia and vaccination, among others. However, the effectiveness of these strategies can be severely affected by human-mediated dog movement. If immigration is important, then the location of origin of dogs imported by humans will be fundamental to define the spatial scales over which population management and research should apply. In this context, the main objective of our study was to determine the spatial extent of dog demographic processes in rural areas and the proportion of dogs that could be labeled as immigrants at multiple spatial scales. To address our objective we conducted surveys in households located in a rural landscape in southern Chile. Interviews allowed us to obtain information on the demographic characteristics of dogs in these rural settings, human influence on dog mortality and births, the localities of origin of dogs living in rural areas, and the spatial extent of human-mediated dog movement. We found that most rural dogs (64.1%) were either urban dogs that had been brought to rural areas (40.0%), or adopted dogs that had been previously abandoned in rural roads (24.1%). Some dogs were brought from areas located as far as ~700 km away from the study area. Human-mediated movement of dogs, especially from urban areas, seems to play a fundamental role in the population dynamics of dogs in rural areas. Consequently, local scale efforts to manage dog populations or their diseases are unlikely to succeed if implemented in isolation, simply because dogs can be brought from surrounding urban areas or even distant locations. We suggest that efforts to manage or study dog populations and related diseases should be implemented using a multi-scale approach.

1. Introduction

Domestic dogs are both beneficial (Serpell, 1995; Raina et al., 1999; Wells, 2007) and problematic not only for human societies (Hampson et al., 2009; Acosta-Jamett et al., 2010a; Dalla Villa et al., 2010; Overall and Love, 2011) but also for wild vertebrates (Knobel et al., 2014; Ritchie et al., 2014; Vanak et al., 2014). Problems related to dogs are often associated to free-roaming animals (Vanak and Gompper, 2009; Dalla Villa et al., 2010). However, free roaming animals are frequently owned (Ibarra et al., 2006; Morters et al., 2014; Sepúlveda et al., 2014a). As a result, the reduction of the incidence of dog-caused problems requires managing owned animals. Dog management includes efforts to reduce population size as well as disease prevention. Attempts to control dog population size often consider surgical sterilization, lethal management and/or contraception (Dalla Villa et al., 2010). However, population modeling suggests that the effectiveness of both lethal and reproductive control strategies on stray domestic animals depend on immigration (Amaku et al., 2010; Lohr et al., 2013). Similarly, vaccination is the most effective alternative to prevent some infectious diseases

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(Cleaveland et al., 2006; Hampson et al., 2009; Morters et al., 2013), but high dog population turnover limits the effectiveness of vaccination and consequently hampers the control of diseases such as rabies (Cleaveland et al., 2006) and canine distemper (Belsare and Gompper, 2015a, 2015b). The size of the target dog population is an important factor that needs to be considered in the design of disease control strategies (Cleaveland et al., 2006), but defining the spatial extent of populations is not trivial (Camus and Lima, 2002).

Population has been defined as "a group of individuals of the same species that live together in an area of sufficient size to permit normal dispersal and/or migration behavior and in which numerical changes are largely determined by birth and death processes" (Berryman, 2002; p. 441). Clearly the concept of population is inextricably linked to a problem of scale (Berryman, 2002; Camus and Lima, 2002; Schaefer, 2006); which leads to ask whether dog management and research are conducted at appropriate spatial scales. More specifically, a key aspect of Berryman's (2002) definition is that the area must be large enough so that the effect of movement in population dynamics is negligible. Importation of dogs by humans into local populations is a common practice (Morters et al., 2014; Sepúlveda et al., 2014a) and such practice has implications for population dynamics and disease management (Morters et al., 2014). Understanding human-mediated movement of dogs is then fundamental to define dog populations and consequently the spatial scales over which management and research should apply.

Dogs in rural settings represent an important issue for public health (e.g., Knobel et al., 2005; Moro and Schantz, 2006) and for the conservation of several native species (e.g., Silva-Rodriguez and Sieving, 2012). For these reasons, diverse studies emphasize the importance of controlling the size and roaming behavior of dog populations in rural settings (Vanak and Gompper, 2009, 2010; Silva-Rodríguez and Sieving, 2012; Belsare and Gompper, 2015a). However, to define proper scales at which population dynamics should be addressed is a difficult task (Camus and Lima, 2002), and consequently multiscale approaches are important to better understand populations (Schaefer, 2006). In the case of owned rural dogs, the minimum spatial unit is likely the household. Given that in most societies the number of dogs per household is likely to be relatively small (i.e., not self-sustainable), it is reasonable to expect that at this scale most of the dogs are imported (e.g., Ortega-Pacheco et al., 2007). At coarser scales, borders between countries can be considered a limit, under the assumption that custom policies limit human-driven dog movement. Intermediate spatial scales, such as study area, can be defined depending on the characteristics of the area, but in general are more subjective (see Camus and Lima, 2002). We expected that the proportion of imported dogs (i.e., dogs brought from other locations) would be high at least at the household and study area scales. Considering the high densities of dogs reported in urban areas (e.g., Acosta-Jamett et al., 2010b, 2015; Astorga et al., 2015a) and previous work in the area (Sepúlveda et al., 2014a), we expected urban areas to be an important source of dogs for rural areas. In this context, our objectives were (1) to determine demographic characteristics of domestic dogs in rural settings, (2) to describe the human influence on births, deaths, and dog movement between locations, and (3) to determine the spatial extent of dog demographic processes and the proportion of dogs that could be labeled as imported at multiple spatial scales. To address these objectives we conducted a study in a large rural landscape of southern Chile, an area where free-ranging dogs are an important concern for animal production (Instituto Nacional de Estadísticas, 2011; Sepúlveda et al., 2014a), public health (Moro and Schantz, 2006) and biodiversity conservation (Silva-Rodriguez and Sieving, 2012; Sepúlveda et al., 2014b; Acosta-Jamett et al., 2015).

2. Methods

2.1. Study area

We conducted our study in Los Rios Region, Southern Chile. The study area extended 30 km east from the Pacific coastline, from the Lingue river's mouth to the north and the Colun river's mouth to the south (39.50°–40.10°S, 72.87°–73.35°W, Fig. 1). The study area surrounds five urban areas (that were not part of the study): Niebla (2202 inhabitants), Corral (3670 inh.), Máfil (3796 inh.), San José de la Mariquina (7790 inh.), and the city of Valdivia (127,750 inh.) (Instituto Nacional de Estadísticas, 2005).

2.2. Study design

For the present study we set a grid of cells of 1×1 km. We excluded the cells that intersected urban areas. The borders of these urban areas were obtained from the Integrated System for Territorial Information (SIIT for its Spanish acronym) (Biblioteca del Congreso Nacional de Chile, 2013). The remaining areas (approximately 2728 km^2) included large extensions of uninhabited landscapes (e.g., native forests, plantations, wetlands, etc.). Therefore, to reduce the probability of selecting cells with no human presence, we used Google Earth™ (Google Inc., 2013) to search for roofs, as a proxy for human habitation, and detected them in 904 cells. Among these we excluded 35 cells, most of them because they were urban, presented urban characteristics or were highly associated to urban areas. To secure the representation of areas located close as well as far from urban areas we stratified the landscape using a 5 km buffer around the borders of urban areas. Cells were then randomly selected using these strata (<5 km and >5 km from urban border), with the restriction that chosen cells could not share a side or a vertex. Considering resource limitation, we selected a sample of 60 cells (30 per strata), but 49 were sampled. Sometimes roofs corresponded to storage buildings, barns, and abandoned buildings (including houses), among others. Other cells could not be reached using regular transportation and some cells were not interviewed to avoid interfering with other processes that involved local communities. In some cases, where cells were occupied but was not possible to interview residents (e.g., those not found at home), we moved to a neighboring cell. Spatial geographical information and files were managed using QGIS (QGIS Development Team, 2013).

From October 2013 to April 2014 we visited every household that we detected at each of the selected cells. Out of 170 households that were occupied at the moment of the visit, 167 agreed to participate, but one of the interviews was dropped from the study because the research participant was underage (<18 years). Consequently, we included 166 interviews from 49 cells in the present report. The median number of interviews per cell was two (range = 1–15).

2.3. The questionnaire

We developed a structured questionnaire regarding dog demographics, management and perceptions related to dogs and their management. The demographics and management sections were designed based on previous questionnaires (Fiorello 2004; Silva-Rodriguez and Sieving, 2011, 2012; Sepúlveda et al., 2014a) that were modified and adapted as needed to meet the objectives of our study. The perception component of the questionnaire will be presented elsewhere. The questionnaire was pretested (the answers were excluded) and necessary changes were incorporated.

To address demographic characteristics of dog populations we