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COMPARISON OF TWO NON-INVASIVE TECHNIQUES TO MONITORING TWO CANIDS IN A PERI-URBAN PROTECTED AREA OF SOUTH-CENTRAL CHILE

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Comparison of Two Non-Invasive Techniques to Monitoring Two Canids in a Peri-Urban Protected Area of South-Central Chile. Zúñiga, A. H., Encina-Montoya, F. & Jiménez, J. E. — Peri-urban protected areas are continually invaded by alien species, and monitoring of these populations is important for their management. To evaluate the detectability of their performance, the use of scats and camera traps was compared for the monitoring of two canid species, one alien, the domestic dog (*Canis lupus familiaris*) & one native, the chilla fox *(Lycalopex griseus*), in a protected area in central-southern Chile. This comparison was carried out for one year, and seasonal variations in the records were analysed. In the case of dogs, differences were observed between techniques, with the use of camera traps being the most successful. These differences were also observed between seasons. In contrast, no differences between techniques were observed for chilla foxes, and no seasonal variations were found. Differences were also observed in the coverage associated with the detection of both species. The ecological and behavioural implications of the results obtained are discussed, which are mainly related to competitor avoidance mechanisms by the chilla fox. We recommend the combined use of both techniques, as this allows us to minimise the biases introduced by each of them separately.

Key words: anthropization, camera traps, detection, scats collection, seasonality.

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Introduction

The loss of natural habitats is one of the main threats to biodiversity (Hanski, 2005), as it limits the food and shelter available to species. This loss is mainly caused by anthropogenic land conversion (Poschold et al., 2005), which tends to increase over time (Zhao et al., 2006; Echeverría et al., 2008). In this context, the establishment of protected areas is one of the most important tools for the conservation of species, since they maintain the expansion of natural habitats under the restrictions of land use change (Watson et al., 2014), thus reducing direct threats to them. However, their effectiveness is in most cases limited because they are small or poorly connected, which affects the dispersal of individuals of different species (Williams et al., 2022). This situation is important for the control of invasive species, which constitute one of the main drivers of biodiversity loss (Bellard et al., 2016). In this sense, the implementation of systematic monitoring of the species present is of particular importance, as it allows the detection of population changes over time (Durant et al., 2011) and the adoption of management plans according to specific demographic scenarios (Gauthier & Wiken, 2003).

Among the invasive species that can affect biodiversity in protected areas is the presence of dogs (*Canis lupus familiaris*), an invasive alien species that is widely distributed around the world (Boitani et al., 2017) and has a significant presence in protected areas. The impact of dogs on fauna has been reported in several ecosystems (Vanak & Gompper, 2002; Silva-Rodríguez et al., 2010; Genovesi et al., 2012; Zapata-Ríos & Branch, 2016), which compromises the conservation status of the species present. Among the species present in the forest ecosystems of southern Chile is the chilla fox (*Lycalopex griseus*), a small canid (4 kg) widely distributed in the Chilean territory, where occupies various diverse habitats (Iriarte & Jaksic 2012). However, it has been affected by habitat transformations, with consequent spatial and trophic responses (Zúñiga et al., 2009; Zúñiga et al., 2021 a). These modifications have had effects on the occurrence of chilla foxes at a local scale, with implications for their conservation (Del Solar & Rau, 2004; Lucherini, 2016).

Monitoring through the use of scats allows obtaining information on the status of carnivore populations at a low cost (Zúñiga et al., 2009; Zúñiga et al., 2022). However, this technique may have a limited effect for the study of some species, which would be explained mainly by their differences in the use of space (Barea-Azcón et al., 2007; Gompper et al., 2006). This situation limits its applicability in different contexts, as well as the subsequent interpretation of the data. In this way, considering the restriction of resources available to carry out wildlife monitoring, knowledge about the success in the implementation of techniques at a local scale is relevant, to optimize efforts in the activities to be carried out. In the present study, the effectiveness of two wildlife monitoring techniques, use of scats and camera traps, for the detection of *L. griseus* and *C. lupus* was evaluated during one year in a protected area in south-central Chile. The hypothesis about the differences in obtaining records using the two techniques for both species was tested.

Material and Methods

Monumento Natural Cerro Ñielol (MNCÑ, 38º 43' S 72º 35' W) is a state protected area in south-central Chile, which is adjacent to the city of Temuco (Fig. 1). It

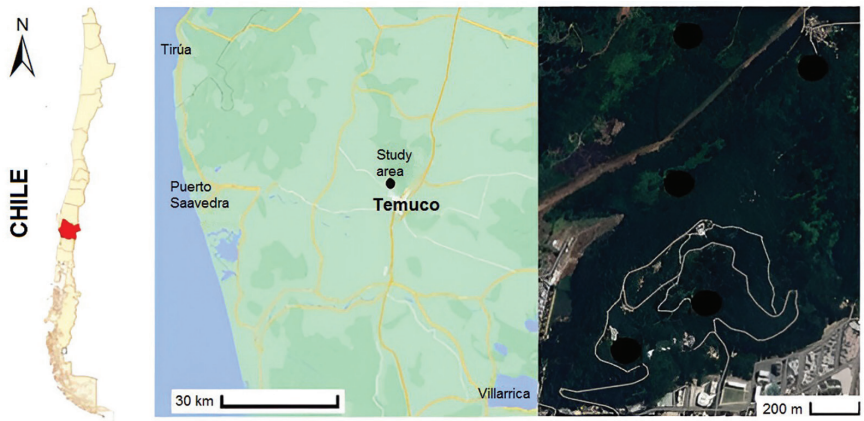

Fig. 1. Study area. The black circles indicate the locations of the cameras traps

Fig. 2. Scats collected in the study area. A — Domestic dog; B — Chilla fox

Fig. 3. Records obtained by camera traps in the study area. A — Domestic dog; B — Chilla fox

has an area of 88 ha, and is located at 200 m above sea level. MNCÑ has a temperate rainy oceanic type climate, with Mediterranean influence (Di Castri & Hajek, 1976). Its vegetation is mainly comprised of deciduous forest, represented primarily by the roble-laurel-lingue formation (Oberdorfer, 1960), with a significant proportion of non-native species (Hauenstein et al., 1988). The carnivorous fauna present in this protected area includes the lesser grison (*Galictis cuja*) and the guigna (*Leopardus guigna*), small carnivores of which there are few records (Zúñiga, unpublished data).

From January to December 2022, camera traps, a non-invasive technique for monitoring carnivorous mammals, were used (Kays & Slauson, 2008). These are photographic devices that are activated when an animal passes in front of them, allowing for its recording and subsequent identification. Five cameras (Bushnell Corporation, Overland Park, KS, USA) were installed on trails, which were kept at an average distance of 350 m from each other, allowing spatial independence, considering the home range of both species (Carbone & Gittleman, 2002). The number of operational cameras made it possible to completely cover the surface of the protected area. For analytical purposes, a value of 30 min was considered between successive recordings, to allow for temporal independence (Chen et al., 2009).

The trails of the study area (4 km) were walked along during the same period every two weeks, in the search of and collection scats of both species of canids. The samples were recognized using morphological and color criteria (Muñoz-Pedreros, 2010; Fig. 2). These were collected and stored in paper bags. The alien canids have species-specific characteristic shapes of their scats that allow them to be distinguished from other species (Chame, 2003). A two-way analysis of variance was carried out (Quinn & Keough, 2002), to evaluate seasonality and sampling technique used for each species. For both the use of scats and camera traps, the number of records/15 days was used as an analysis metric. To evaluate the effect of habitat on the techniques used to record the species, canopy coverage, shrub vegetation, herbaceous vegetation and dead wood were estimated at each recording point (camera traps and sites where each scats was detected), considering a radius of 100 m^2 (Zúñiga et al., 2021 b). These coverages were compared based on the records obtained using non-dimensional metric scaling, based on Euclidean distances (Clarke et al., 2014).

Results

With a total sampling effort of 1430 nights/camera-traps, 119 photographs were obtained for the dog (12, 28, 53, 26 for summer, fall, winter and spring, respectively; Fig. 3, A) and 15 for the chilla fox (5 for fall, winter and spring, respectively; Fig. 3, B). For scats, 72 were collected for the dog (22, 18, 9, 23 for summer, autumn, winter and spring, respectively), and 66 for the chilla fox (10, 13, 14, 29 for the same periods).

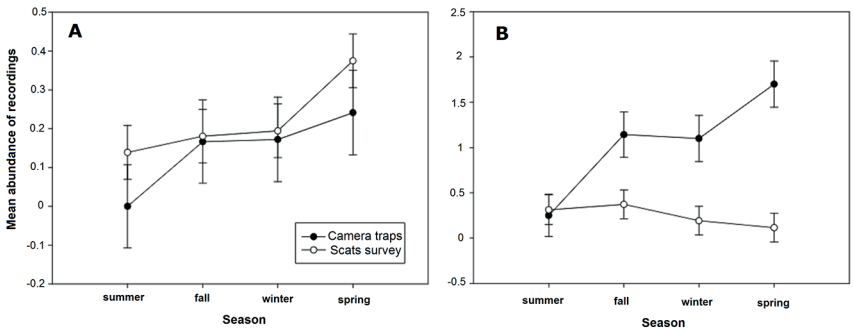

Fig. 4. Average numbers of records obtained for both sampling techniques on chilla fox and domestic dog across the seasons studied. The bars indicate the standard deviation for each period

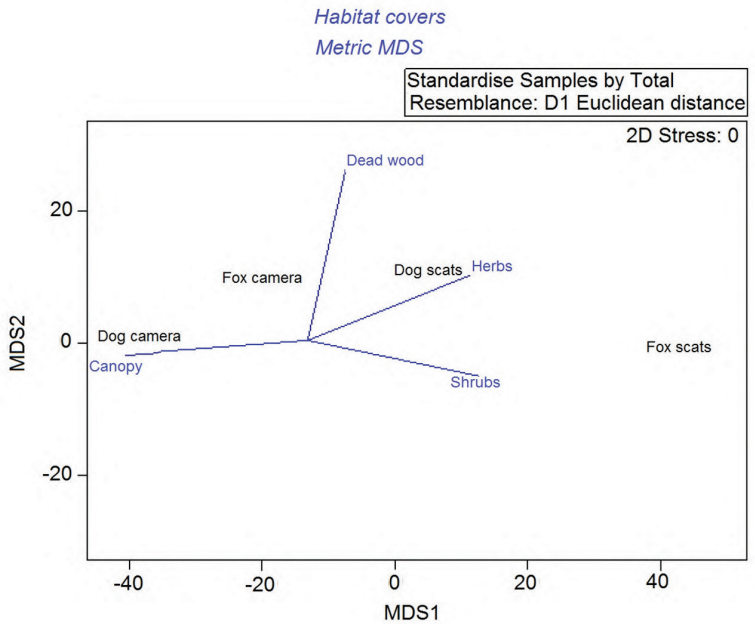

Fig. 5. Non-metric dimensional scaling based on the coverage of the sites where domestic dogs and chilla foxes were recorded

When comparing each species, the detection ability in the use of camera traps and scats showed a differed trend. For the dog, a significant difference between techniques were obtained ($F = 29.32$, $p < 0.0001$). The photographic records being the one with the highest recording frequency (Fig. 4), which happened across all the seasons ($F = 3.38$, $p = 0.018$). While an increase in the photographs towards the spring was evident, the scats decreased in this same period. The interaction between the two variables was significant ($F = 6.98$, $p = 0.001$). In contrast, no differences were observed between techniques for the chilla fox ($F = 0.49$, $p = 0.230$); the two techniques showed the same seasonal trend ($F = 0.79$, $p = 0.074$), and no interaction between these variables were found ($F = 0.09$, $p = 0.083$). Regarding the effect of habitat cover on the detection of species, an interaction of the canopy on the detection of dogs by cameras was obtained, while dog scats were associated to herbaceous cover (Fig. 5). The camera records of foxes had a low association with dead wood, just as their scats were associated to herbaceous and shrub cover. When the coverage among the recording points (scats and cameras) was compared, significant differences were observed only in the herbaceous coverage (Mann-Whitney test, $U = 29$, $p < 0.001$, mean sites with cameras: 4.88% cover; mean sites with scats: 13.50% cover) and canopy coverage ($U = 0$, $p < 0.001$, mean sites with cameras: 74.60% cover; mean sites with scats: 14.71% cover).

Discussion

The differences in the frequencies of records obtained for both species could be explained first of all by their relative abundances, being the domestic dogs a higher. This fact has been reported in various cities throughout Chile (Ibarra et al., 2006; Acosta-Jamett et al., 2010; Schüttler & Jiménez, 2022; Silva-Rodríguez et al., 2023), which makes its incursion

into protected areas possible, which is consistent with other studies (Mella-Méndez et al., 2019). In contrast, the chilla fox has low densities (Jiménez, 1993; Zurita et al., 2024), which was reflected in its low detection. In addition, the interference from dogs on the foxes would result in their avoidance behaviors (Silva-Rodríguez et al., 2010; Gálvez et al., 2021; Malhotra et al., 2021), and consequently minimizing their occupation at the local scale. This scenario was also reflected by the fact that most of the foxes' scats were detected on marginal sites of this protected area (Zúñiga et al., 2022), which in turn may limit the probabilities of detection by the cameras.

The strong seasonal effect on dog detection was unexpected by been due to its generalism in the use of space (Boitani et al., 2017). This scenario is consistent with an increase in the occurrence of local prey in their diet (Zúñiga, unpublished data). For chilla fox, although part of its occupancy dynamics were associated with its feeding habits (Zúñiga et al., 2008), these have not been reflected in this study area. This suggests that the chilla might change the diet (Zúñiga et al., 2022).This should be studied further in the future.

The relationship between canopy cover and the detection of dogs by cameras differs from what was observed in previous reports, where dogs avoid forest patches (Dechner et al., 2018). This suggests that in the study area the use of forest by dogs would be transitory, which would allow individuals to move to the most open sites. The lack of association of coverage with camera detections for dogs may be biased. Because cameras were only installed under in sites with high canopy coverage. We did this to avoid the cameras to be stolen by people that visit the area (Zúñiga et al., unpublished data). Despite his limitation, and considering the fox avoidance in areas frequented by dogs, we should caution on the sampling design that should be improved in future studies. On the other hand, the association of scats with grasses and shrubs is consistent with the behavior of both canids to visit open habitats (Fox & Cohen, 1978; Barja et al., 2001).

In conclusion, it was found that both species of canids respond differently to monitoring techniques. The presence of the chilla fox, the native species of interest, was underrepresented when monitored with cameras, which we believe it was better reflected by their scats. We would suggest to combine both techniques in future monitoring plans (Roda et al., 2022), which should be complementary for assessing the activity/relative abundance of these canids. We would also suggest controlling the dogs in the protected area. This would alleviate the impact on the local biodiversity and should be reflected in the expected use of space by the chilla fox.

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