

SHORT COMMUNICATION

## Dogs can detect scat samples more efficiently than humans: an experiment in a continuous Atlantic Forest remnant

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**ABSTRACT.** Scat-detection dogs have been used to locate feces of rare and elusive species across tropical biomes. However their detection efficiency in relation to human observers has rarely been evaluated. In this study, we evaluated the ability of a scat detection dog to locate feces in comparison with human researchers. Human researchers and a scat detection dog surveyed for deer (*Mazama* spp.) feces in dense ombrofilous Atlantic forest in the Paranapiacaba continuum, SP, Brazil. A controlled experiment was used to assess the maximum effective perpendicular distance from a transect search line that the dog could detect a *Mazama* spp fecal sample. Results from a linear regression model revealed that the maximum effective perpendicular distance from a transect search line that the dog could detect a scat was 7.2 m. The detection success from our surveys in the Atlantic forest was zero for humans and 0.15 samples/ha or 0.20 samples/km walked for the dog team. Our results demonstrated the importance of scat-detection dogs for non-invasive sampling and provide data relevant for the design of future studies.

**KEY WORDS.** Deer; fecal samples; *Mazama*; sampling.

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Fecal samples have a wide range of applications for temperate and tropical wildlife studies (KOHN & WAYNE 1997, BEJA-PEREA *et al.* 2009, GONZALEZ *et al.* 2009). A common challenge for all such studies is that of finding large amounts of fecal samples in the field. The challenge of obtaining sufficient quantities of fecal samples becomes even more acute when research involves prey species that have developed strategies to make scats cryptic to avoid predation. One possibility to locate such samples is the use of a scat-detection dog (SMITH *et al.* 2001). The use of detection dogs to locate scats has proved to be a flexible and adaptable survey technique. Scat-detection dogs have been used to locate fecal samples from whales in the North Atlantic (ROLLAND *et al.* 2006) and to locate fecal samples from a variety of carnivore species in various North American ecosystems (SMITH *et al.* 2003, WASSER *et al.* 2004, SMITH *et al.* 2005, HARRISON 2006, LONG *et al.* 2007, REED *et al.* 2011). Scat-detection dogs have also been used in the Cerrado and Amazon biomes of Brazil to locate carnivore and xenarthran fecal samples, (MICHALSKI *et al.* 2011, VYNNE *et al.* 2011). However the ability of scat-detection dogs to locate ungulate fecal samples in the Neotropics has yet to be demonstrated. The present study aimed to compare the sampling efficiency of a scat detection dog to that of human researchers.

The present study was conducted in the Paranapiacaba Ecological Continuum, which is part of the Southern Reserves of the Brazilian Atlantic Forest World Heritage Site. More specifically research activities took place at the Carlos Botelho State Park (24°08'S, 47°59'W) and the neighboring Intervalles State Park (24°16'S, 48°52'W), which together protect an area of 78,837 ha (37,433 and 41,404 ha Carlos Bothelo, Intervalles, respectively) (Fig. 1). The climate in the region is humid temperate ("Cfa", according to the Köppen climate classification), with hot austral summer temperatures associated with high rainfall and the absence of a dry winter. A variety of primary and secondary Atlantic Forest types are found within the protected areas including dense ombrofilous forest. The occurrence of three deer species has been confirmed in the region: *Mazama americana* (Erxleben, 1777), *Mazama gouazoubira* (Fischer 1814), and *Mazama bororo* Duarte, 1996 (BLACK-DÉCIMA *et al.* 2010, VOGLIOTTI & DUARTE 2010). Populations of the small red brocket deer (*M. bororo*) have been recorded in both Carlos Botelho and Intervalles State Parks, with an estimated maximum of 615 individuals and a density of 1.51 ind/km<sup>2</sup> recorded at Intervalles (GONZÁLEZ & GARCÍA 2010, VOGLIOTTI & DUARTE 2010). Due to similarities in forest types, topography and anthropogenic pressure between the neighboring areas we assumed that deer population densities are similar in both parks.

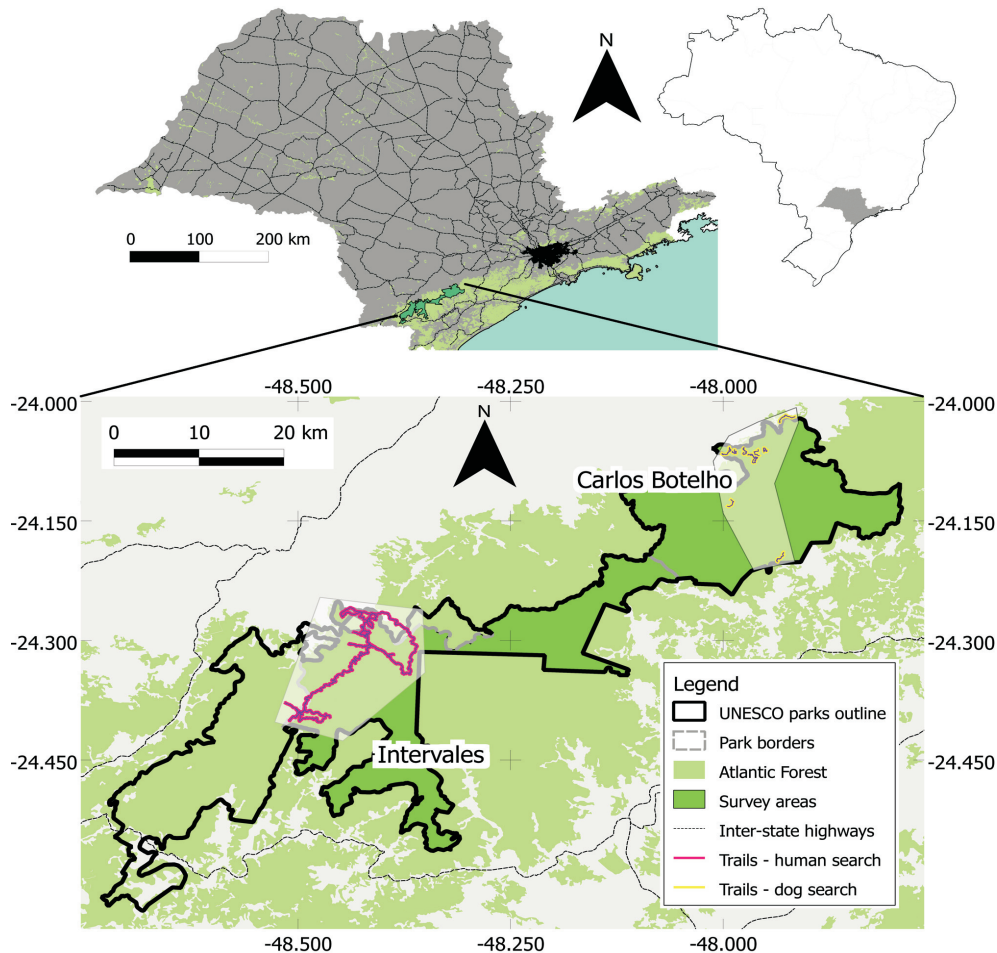


Figure 1. Study area showing locations of human and scat detection dog survey trails in the Paranapiacaba Continuum, SP, Brazil.

The dog (named Granada), a female of mixed breed, was trained by the Military Police of São Paulo State narcotics detection program. There were three main phases in the training program, which takes approximately six months for an “average” detection dog to complete (our female completed the training program in five months). In the first phase a toy (e.g., tennis ball) is hidden for the dog to find. After this, the toy is hidden together with the target odor, in order that the dog associates the target odor with the toy. In the final phase only the target odor is hidden and when the dog succeeds in finding the correct odor it is rewarded with the toy. During all phase’s dogs were trained off-lead such that the search area was not limited by any physical connection to the handler who only calls for the dogs return when visual contact is lost. The only modification to the standard police training program was that the target odor was changed to a mix of *Mazama* species feces obtained from captive individuals. To ensure that fecal samples were as similar as possible to those from wild individuals the deer were

fed only with fruits and fresh leaves prior to the collection of training feces. In the field, when the dog finds a deer scat sample, it sits nearby and barks. After that, the handler provides the reward of play with a tennis ball.

From April to June 2011, 194.9 km of trails were walked across Intervales State Park (Fig. 1) by two observers visually searching for fecal samples. Based on detections of >45 fecal samples from non-target species – *Tapirus terrestris* (Linnaeus, 1758) and unidentified carnivores – the sampling strip width for human observers was estimated at two meters (i.e. one meter either side of the survey trail).

Between March and May 2011, 39 km of trails were walked across the Carlos Botelho State Park by a dog team (Fig. 1). The dog team consisted of a handler, the dog (working off-lead) and an orienteer that did the GPS navigation. Surveys by the dog team were carried out between 9:00 and 15:00 h and lasted on average six hours (range: 5-7 hours), with regular pauses to provide rest and water to the dog. In order to deter-

mine the dogs effective sampling strip width an experiment was carried out in a rubber tree, *Hevea brasiliensis* (Willd. ex A. Juss.) Müll. Arg., plantation. A total of 122 fecal samples were collected from captive *Mazama* individuals. Fresh (<12 hours after defecation) fecal samples were collected and maintained frozen until the day of the experiment. The 122 fecal samples were distributed every 10 m along a transect at known perpendicular distances (0, 3, 6, 9, 12, 15, 18, 21m). Perpendicular distances at each 10 m interval were randomly selected and fecal samples were placed alternately one to the left and one to the right of the transect line. The dog handler walked along the transect line with the dog working freely off-lead. We used linear regression to estimate the maximum perpendicular distance from the transect line that a sample could be found. In the regression model we used perpendicular distance (modeled as a continuous variable) to predict the response of the percentage of samples recovered. We used the lower 95% confidence interval from the regression model to estimate the distance until which the dog would effectively detect a fecal sample, defined as the perpendicular distance value where the lower 95% confidence interval was 0.

Overall the dog detected 29% of our experimental fecal samples. We found a clear linear decline in detections with 57, 44 and 17% of the samples detected at perpendicular distances of 0, 3 and 6 m, respectively and no samples were detected at the other distances. The effective perpendicular search distance estimated from the lower 95% confidence interval of the linear regression model ( $R^2_{\text{adj}} = 0.9762$ ,  $F_{1,2} = 124.2$ ,  $p = 0.008$ ) was 7.2 m. We rounded this value to 7 m, providing a strip width of 14 m. Therefore by multiplying the total distance walked by the strip width, we calculated the sampling area of the field surveys as 54.6 ha for the dog team and 39.0 ha for human observers.

Human observers did not detect any deer feces during surveys; however deer tracks were recorded on 24 separate occasions. In comparison, the dog detected a total of eight fecal samples, providing a detection success of 0.15 samples/ha or 0.21 samples/km for the dog team. A number of factors could explain the inability of human observers to detect feces when deer were known to be present, including: low density of target species, lack of observer skill/training and the removal of feces by invertebrate predators (NORRIS & MICHALSKI 2010). Both human observers had >5 years experience of surveying mid and large bodied mammals in Neotropical forests. We therefore believe observers reflect at least the "norm" in terms of human ability to detect feces. The density of deer species in the region is not high but is within the expected range for Neotropical cervids (BLACK-DÉCIMA *et al.* 2010, GONZÁLEZ & GARCÍA 2010, VOGLIOTTI & DUARTE 2010). As we assume that the density was the same for both canid and human observers, we do not expect it to cause differences in detection success. Similarly there is no reason to believe that there exist differences in invertebrate or vertebrate predation on and removal of deer fe-

ces between areas surveyed by humans and the dog team. We therefore conclude that human inability to detect feces is a reflection of the challenging environment where continuous leaf fall obscures pellets and the characteristics of the target species that deposit small sized fecal pellets which do not remain in clearly visible clumps. This is supported by results from the dog team who were able to recover small (<5) numbers of fecal pellets that were covered by leaves and invisible to human observers.

This dog sampling success in the Paranapiacaba ecological continuum is lower than that reported from North America, for example in the Carrizo Plain National Monument and in the LoKern Natural Area, both in California, scat dogs detected from 0.43 to 5.37 presumptive kit fox, *Vulpes macrotis mutica* Merriam, 1902, fecal samples/km (SMITH *et al.* 2003). It is important to point out that the dogs' detection success in Paranapiacaba could have been higher. The warm and humid weather in Carlos Botelho State Park may have negatively influenced the dogs' ability to detect scats as odor particles do not disperse at high moisture levels and high temperatures increase canid panting rates (SMITH *et al.* 2003, WASSER *et al.* 2004), which can reduce sniffing rates and therefore limit scat detection. Another factor that could explain the lower success in Paranapiacaba is the fact that herbivore feces have a weaker odor compared with those of the carnivores surveyed in the other studies (SMITH *et al.* 2003, WASSER *et al.* 2004, SMITH *et al.* 2005, HARRISON 2006, LONG *et al.* 2007, REED *et al.* 2011).

For the first time we demonstrated how important a scat detection dog was to obtain fecal samples, which would otherwise be missed by human researchers in the Neotropics. Although the dog did not follow a fixed path and may therefore miss samples close to the trail, we found that the overall area that is effectively covered more than compensates for these losses. This is particularly true for deer fecal pellets which are easily missed by human observers especially when covered by leaf litter on the forest floor. Scat-detection dogs clearly have the potential to obtain fecal samples that when analyzed with molecular tools can provide reliable baseline information, such as geographical ranges and population estimates, for poorly known Neotropical species (GONZÁLEZ *et al.* 2009, WEBER & GONZÁLEZ 2003). However, scat-detection dogs remain an under exploited resource by Neotropical researchers.

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