TITLE

Human-related factors regulate dog presence in protected areas: implications for conservation and management control

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Running title: Human controls of domestic dogs in protected areas

Abstract

The presence of domestic species such as dogs *Canis familiaris* in protected areas represents a conservation problem due to competition, predation and/or disease transmission to native species. This introduced species may increase their ranging activity towards protected areas by the planning of new urban areas and by the spread of houses and small urban settlements because they are abundant in those environments. Dogs' effects on wildlife in protected areas may depend on their nature (domestic dogs vs. feral dogs), on where they are found and on the factors controlling their space use. In order to improve our ability to design effective control policies, we investigate the factors affecting detection of dog tracks in a Mediterranean national park which protects the world's most critically endangered felid species, the Iberian lynx (*Lynx pardinus*).

We studied the presence or absence of dogs at 69 2x2 km grids and analysed the associated environmental and/or human constraints by logistic regression models. We failed to detect dogs in areas away from anthropogenic edges (track census effort above 470 km) so according to our results, dogs at DNP may be domestic dogs incurring occasionally into the protected area from the surrounding matrix. The detection of dog tracks was dependent on the presence of people and consequently on the resources they provide. The direct threats of dogs to wildlife may therefore not spread throughout the entire reserve or along the entire edge length. Any strategy aimed at reducing domestic dogs' impact in areas of conservation concern where feral dogs populations are not established should focus on the presence of settlements and

their spatial spread, local awareness and regulation to encourage local people to restrain their dogs' movements as well as control measures on boundaries and areas close to human dwellings.

Keywords

Anthropogenic effect; *Canis familiaris*; domestic dog; edge effect; feral dogs; generalist predator; human dwelling; protected areas.

Introduction

The introduction of non-native species into ecosystems represents one of the causes of native species decline and endangerment (e.g. King, 1985; Soulé, 1990; Williamson, 1999; IUCN, 2012). Due to human population growth, urban sprawl and the rapid urbanization of natural landscapes, humans and with them their companion animals such as domestic dogs *Canis familiaris* may be closely in contact with wildlife in many areas (Ordeñana *et al*., 2010) including places where nature conservation is a priority, such as protected areas and national parks created to protect populations of vulnerable or threatened species. These non-native species introduced by human across the globe (Wandeler *et al*., 1993) may therefore increase their ranging activity towards the remaining natural landscapes extending within those areas the deleterious human-associated effects.

In areas of conservation concern presence of companion animals like domestic dogs may pose distinct threats including competition, interbreeding, predation and disease. Dogs harass and kill wildlife exhibiting in many cases a "surplus" killing behaviour (e.g. Iverson, 1978; Kruuk & Snell, 1981; Manor & Saltz, 2004; Banks & Bryan, 2007), compete with wildlife (e.g. Boitani, 1983; Butler & du Toit, 2002; Butler, du Toit & Bingham, 2004; Vanak, Thaker & Gompper, 2009) and spread disease like rabies, parvovirus or canine distemper (e.g. Sillero-Zubiri *et al.*, 1996; Cleaveland *et al*., 2000; Fiorello *et al.*, 2004; Fiorello, Noss & Deem, 2006; Vanak & Gompper, 2009*a*). Moreover, dogs such as mid-sized canids, can also exert a top-down influence on smaller carnivores through interference competition or intraguild predation (e.g. Glen & Dickman, 2005; Mitchell & Banks, 2005; Vanak & Gompper, 2009*b*). Studying where domestic dogs came from in protected areas is needed in order to manage them and prevent their potential impacts on native fauna. Dogs at protected areas may exhibit varying levels of human reliance, from domestic dogs whose needs are satisfied directly or indirectly by people (i.e. owned dogs, urban or rural free-roaming dogs and/or village dogs (Vanak & Gompper, 2009*a*)) and spend time sporadically in natural protected areas, to feral dogs living and reproducing freely in protected areas. The effects of dogs on wildlife may therefore depend on their nature (i.e. domestic dogs vs. feral dogs), on where they are found and on the factors controlling their numbers and space use.

As a heavily human-subsidized species, domestic dogs exhibit higher densities in areas close to human residences or places with a high density of houses (e.g. Odell & Knight, 2001; Ordeñana *et al.*, 2010) as well as in areas near natural reserve borders with agriculture, where rural human residences are nearby. In contrast, they may exhibit lower densities in areas contiguous to large tracts of native forest, which may be acting as a buffer to the entrance of dogs (Srbek-Araujo & Chiarello, 2008).

Domestic dogs' records decrease from anthropogenic matrices to forest patch edges (Torres & Prado, 2010). Hence, if we consider protected areas as large patches, presence and therefore direct negative effects of domestic dogs on native fauna (i.e. predation and/or competition) may decrease from the anthropogenic matrix to the protected area interior reaching their maximum at the borders. This could strengthen the negative anthropogenic edge effect associated with these artificial border areas (Woodroffe & Ginsberg, 1998; Revilla, Palomares & Delibes, 2001) diminishing therefore the reserve's effectiveness in conserving wildlife.

Feral dogs are meanwhile completely wild and independent of human-derived materials as food sources (Nesbitt, 1975; Green & Gipson, 1994). They depend almost exclusively on wild-caught food (e.g. Marsack & Greg, 1990; Glen & Dickman, 2005; Mitchell & Banks, 2005; Campos *et al*., 2007; Glen & Dickman, 2008) and might not exhibit any human association. The direct threats of feral dogs to wildlife may therefore spread throughout entire protected areas.

In this context we studied the patterns of detection of dog tracks and the associated environmental and/or human constraints that could influence their presence in a fully protected Mediterranean area, Doñana National Park (DNP), with high potential for *dog-arrival* due to its proximity to urban and rural settlements and with the potential of *dog-settlement* due to its size.

Our main research goals were to answer: (1) where are dogs present at DNP? And (2) what factors predict dog presence? A priori, we hypothesised that dogs using DNP might come either from a domestic dog population formed by individuals that incur occasionally from the surrounding matrix, or from a feral dog population living and reproducing freely. In the first case, we would expect that dogs are heavily dependent on humans and are more abundant at the edges of the protected area close to human settlements than far away from these edges. In the second case, we would expect that dogs avoid human association, are more evenly distributed throughout the protected area, and their presence or abundance related to environmental features describing habitat suitability or potential wild food availability. DNP is optimal for the design of a study of this type since 1) part of the protected area is surrounded by human settlements and others are not, and 2) it is large enough to potentially hold a feral dog population in its interior.

Study area

The study was carried out at Doñana National Park (DNP), a flat sandy area located in south-western Spain (50,720 ha, 37º9´N, 6º26´W) at sea level. We defined the anthropogenic DNP edge as the northern and western edges in close contact with human settlements, crop fields and a high-traffic highway, and the natural DNP edge as the southern edge limiting with the Atlantic Ocean and the eastern edge limiting with the Guadalquivir River through a 27,000 ha marshland area (Fig. 1).

Population in the main suburban settlement (situated in the western vicinity and separated from the DNP by a paved road) undergoes great variation between winter and summer, as it is mainly a summer resort occupied by about 2,710 people in summer seasons. The village situated in the north, and separated by the DNP from the marshland area, is occupied by about 1,635 year-round residents, although during a spring pilgrimage, the number of visitors can reach up to one million people. There are also private large and medium-sized farms used for agriculture as well as six visitor centers, hiking and cycling paths, recreation zones and bird observatories in the nearby area. The DNP is fenced but the fence is permeable to small and medium-sized animals including dogs. Free access is forbidden to people and access to the core area and the dirt-road network inside the DNP is restricted to the park staff and researchers.

The climate is Mediterranean sub-humid, with mild, wet winters, and hot, dry summers, and an average annual rainfall around 550 mm. There are three main biotopes in the park: scrubland, dunes, and marsh (Valverde, 1958). The dune area is situated at the western border of the protected area limited by the Atlantic Ocean and the marsh area at the northern and eastern borders limited by the Guadalquivir River. The Mediterranean scrubland represents approximately half of the National Park surface area and is mainly characterised by heterogeneous patches of xerophytic species such as *Halimium* sp. and *Cistus* sp., and hydrophytic ones such as *Erica* sp., with some patches of *Juniperus phoenica* and *Pistacia lentiscus* shrubs. Interspersed among the scrubland there are scattered cork oak trees (*Quercus suber*) and wild olive trees (*Olea europea*), and a few patches of pine *Pinus pinea* and eucalyptus *Eucalyptus* sp. plantations.

Among larger mammals wild boar (*Sus scrofa*), red deer (*Cervus elaphus*) and fallow deer (*Dama dama*) are frequent. Wild carnivores include red fox (*Vulpes vulpes*), Eurasian badger (*Meles meles*), Egyptian mongoose (*Herpestes ichneumon*), common genet (*Genetta genetta*), least weasel *(Mustela nivalis*), European polecat (*Mustela putorius*), Eurasian otter (*Lutra lutra*), wild cat (*Felis silvestris*) and Iberian lynx (*Lynx pardinus*). 14 small-medium sized mammal species have been recorded in DNP, as well as 397 bird species, approximately half of which are breeding in the park.

Field methods

To evaluate detection of dog tracks we carried out systematic track surveys on sandy paths at 69 2x2 km^2 grid cells located within the entire scrubland and dune areas of the protected area during the wet season of 2007-08 and 2008-09.

We sampled for dog tracks in each square by slowly walking (ca. 1.5 km/h) at least 3 km along available pathways (i.e. sandy roads and firebreaks). Once a track was detected, we georeferenced it using a GPS. We re-sampled the same path (leaving at least seven days between samplings) a second time in a few squares until completing 3 km if during the first sampling there were insufficient available paths within the square to achieve this distance. We always carried out surveys at least three days after any rainfall.

Environmental quality of the sampling grids to hold a feral dog population was assessed by sampling potential prey availability and general habitat structure. Feral dogs are habitat generalists and opportunistic foragers depending almost exclusively on a wide variety of wild-caught food (e.g. Boitani *et al*., 1995; Marsack & Greg, 1990). Potential prey availability was estimated by counting tracks of small mammals, European rabbits (*Oryctolagus cuniculus)*, red partridges (*Alectoris rufa*), domestic cows *(Bos taurus)* and horses (*Equus caballus*) and wild ungulates such as the fallow deer (*Dama dama)*, the red deer (*Cervus elaphus)* and the wild boar (*Sus scrofa*). Prey such as small mammals, rabbits, partridges and young of wild ungulates might be hunted by feral dogs, but adults of many species are consumed as carrion (e.g. Sillero-Zubiri & Macdonald, 1997; Butler *et al*., 2004; Aiyadurai & Jhala, 2006). Prey species were surveyed by walking between 7 and 10 25 m-long transects of approximately 1.7 m wide (i.e. the width of a four-wheel-drive car) and separated by at least 300 m within each 2x2 km grid. During the first year, prey transects were carried out throughout the wet season, when tracks from dogs were surveyed, but during the second year, we concentrated samplings within the month of April to avoid possible intermonthly variations in abundance for some species (e.g. see Kufner, 1986; Palomares *et al*., 2001 for small mammals and European rabbits, respectively.

In order to identify main habitats at DNP (i.e. dunes, pine reforestation and Mediterranean scrubland), general habitat structure was recorded for the first year. We estimated visually the percentage of open ground cover, and the percentage and modal height of three vegetation categories: short shrub (i.e. xerophytic species such as *Halimium* sp. and *Cistus* sp), tall shrub (i.e. *Erica* sp., *Juniperus phoenica* and *Pistacia lentiscus* shrubs) and trees. The estimation of these variables related to habitat structure were carried out in a circle of 15 m radius around the sampling point every 300 m on transects walked for dog and prey tracks. For each square sampled, we averaged the value obtained at the vegetation sampling points.

Data analyses

We examined different environmental and/or human-related factors explaining the detection of dog tracks within each 2x2 km grid at DNP using generalised linear models with a binomial error distribution and a logit link function (logistic procedure in SAS® 9.2 (SAS Inst. Inc., Cary, NC)). Non-biological factors (i.e. methodological and climatic variables) have been previously reported as potentially affecting results of track censuses (Soto, Desniça & Palomares, 2010); therefore we also incorporated in the model fitting these factors to control for their potential effect.

Each grid cell was associated with a set of habitat variables as vegetation type (dunes (> 60% of open groundcover on average inside the grid), pine forest (> 60% of pine vegetation on average) and Mediterranean shrub (> 60% of shrub (short or tall) vegetation on average) and prey abundance (kilometric abundance index of total prey) and with variables describing their location in DNP by calculating Euclidean distance from the grid cell centre to every infrastructure.

We used a two-step approach to analyze data. First, we assessed which methodological and/or climatic variables potentially affect dog detectability and selected the best-fitting model using an information-theoretic approach (Burnharm & Anderson, 2002). Variables considered to be included in models were the observer who carried out censuses (three and two observers for both study years respectively) (*Obs*), relative humidity (%) on census day (*Hum*), days since last rain (*Rain*), year (*Year*) and the maximum temperature (ºC) calculated as the average of the maximum temperature on the census day and the maximum temperature two consecutive days before the census day (*Temp*). Climatic data was obtained from a meteorological station located inside DNP (Latitude: 37º 1’18’’, Longitude: 6º 33' 17") *http://icts.ebd.csic.es*.

Secondly, we used this best-fitting model as a null model to develop a set of a priori models of dog tracks’ detectability at DNP based on three groups of hypotheses stemming from the different variables considered in relation to 1) the possible human dependence of dog tracks’ detectability (i.e. dogs being domestic), 2) the possibility of dogs coming from a feral population (i.e. dog tracks’ detectability related to environmental and/or prey variables), or 3) dogs coming from a combination of both domestic and feral populations. Variables included in models were the minimum distance to nearest single house or visitors centre (*D_HOU*), minimum distance to human settlements (*D_VIL*), distance to nearest paved road (*D_RD*), distance to anthropogenic edge of DNP (*D_ANT*), distance to natural edge of DNP (*D_NAT*), Kilometre Abundance Index of total prey (*Pt*) and the vegetation category; dunes, pine forest, scrubland (*Veg*).

Initially, the correlation among variables was explored using Kendall’s tau statistics, in order to eliminate highly correlated variables (tau > 0.4) and among them; we retained the more ecologically meaningful ones.

We used the Akaike Information Criterion (AIC) corrected for a small sample size (AIC_c) and the difference in AIC_c between each model and the model with the lowest AIC_c (ΔAIC_c) to rank the models according to their capacity to describe the data parsimoniously (Burnharm & Anderson, 2002). The model with the lowest AIC_c and those with $\Delta AIC_c \leq 2$ were considered to be supported. ΔAICc values were used to compute Akaike’s weights (ω_i), which is the weight of evidence that a model is the best approximating model given the model set (Burnham & Anderson, 2002) and is defined as

$$\omega_i = \exp(-1/2\Delta_i)/\sum^{R}_{r=1}\exp(-1/2\Delta_r).$$

In addition, the relative variable importance of predictor variable j (ω_j) was determined as the sum of the ω_i across all models where j occurs. Larger ω_j values indicate a higher relative importance of variable j compared to other variables.

For each hypothesis we used data from both years and we began by fitting all variables included and then successively removing the terms that decreased the AIC the most (Crawley, 2002).

Finally, we explored the classification accuracy of the selected model(s) using the nonparametric estimate of the area under the curve (AUC) of receiver-operating characteristic plots (Hosmer & Lemeshow, 2000). AUC indices range from 0.5 to 1, with ranges from 0.5 to 0.7 indicating poor discrimination, from 0.7 to 0.8 acceptable discrimination, from 0.8 to 0.9 good discrimination, and > 0.9 outstanding discrimination. The AUC measure from the ROC curve is considered useful for comparing the performance of the detection of dog tracks-absence model in a threshold-independent fashion (Fielding & Bell, 1997).

Results

A total of 471 km was walked and 72 dog tracks were found during surveys (Fig. 1). We detected dog tracks at 16 and 12 grid cells surveyed in each study year, respectively.

Four anthropogenic variables were strongly correlated. In particular, distance to the anthropogenic edge of the National Park (*D_ANT*), distance to nearest village (*D_VIL*), distance to nearest paved road (*D_ROAD*) and distance to the natural edge of DNP (*D_NAT*). Analyses were focused on distance to the anthropogenic edge of DNP and distance to the natural edge of DNP.

The best-fitting model explaining detection of dog tracks based on non-biological factors included humidity (*Hum*) and days since last rain (*Rain*). Humidity was positive but non-significant (odds ratio = 1.035, χ^2 = 2.159, P=0.142) whereas days since last rain was negatively and significantly correlated with detection of dog tracks (odds ratio = 0.931, χ^2 = 4.286, P=0.035). Both predictors were therefore included as covariables in further analyses.

The analysis of dog tracks' detectability based on human-related, habitat and prey variables showed that the a priori hypothesis best adjusted to data only included human-related predictors.

The best model describing the detection of dog tracks at DNP after adjusting for detection probability variables in the null model included the distance to the anthropogenic edge of DNP (explaining 27.6 % of the deviance); the next model included the distance to the anthropogenic edge of DNP and the distance to the natural edge of DNP (models 1 and 3, Table 1).

Detection of dogs was significantly and negatively associated to the distance to the anthropogenic edge of DNP (odds ratio = 0.737, χ^2 = 8.020, P=0.005) (Fig. 2). Equation for this model (model 1, Table1) is:

$$\text{logit}(P) = -3.32(\pm 1.86) - 0.31(\pm 0.11)D\_ANT + 0.05(\pm 0.02)Hum - 0.06(\pm 0.04)Rain$$

where P is the probability of dog occurrence; values within parentheses are standard errors.

The relative variable importance of this anthropogenic variable determined as the sum of the ω_i across all models where the variable occurred was ω_j=0.999. The discriminating ability of the top model was AUC = 0.802 (P < 0.0001).

Discussion

Results show that the detection of dog tracks at DNP was associated with distance from the park boundary with human presence, a synthetic indicator of human influence that captures the effect of distance to nearest village and nearest paved road.

We found a high number of dog records near the reserve's borders where rural and suburban households were closer and we were unable to detect signs of dogs far away from these anthropogenic DNP edges in spite of our large census effort. Additionally, dog tracks' detectability did not seem to be related to the environmental variability of DNP such as vegetation type or prey availability.

This lack of association between dogs and variables describing habitat suitability or potential wild food availability, their dependence on human-related variables and their higher abundance at the edges of the protected area close to human settlements compared to areas far away from these edges, support our hypothesis that dogs using DNP come from a domestic dog population formed by individuals that arrive sporadically from the surrounding matrix (i.e. owned dogs, urban/rural free-roaming dogs or village dogs (Vanak & Gompper, 2009*a*)) and not from a feral dog population living and reproducing freely. The lack of association between detection of dog tracks and wildlife food resources possibly also reveals the dependence of dogs on human-derived materials, which is typical for the vast majority of dog populations for which diet has been studied (Atickem, 2003; Butler *et al.*, 2004; Vanak, 2008; Vanak & Gompper, 2009*b*).

Feral dogs survive and reproduce independently of human assistance but some feral dogs use human garbage for food (Green & Gipson, 1994). A feral dog population established inside DNP could therefore use the edge of the protected area to access human subsidies. Nevertheless, the primary feature that distinguishes feral from domestic dogs is the degree of reliance on humans, so if dogs using DNP come from a feral dog population living and reproducing freely but accessing human subsidies for food, we would expect dog detectability to be dependent on habitat suitability and/or wild food availability and marginally dependent on human-related variables.

In contrast with domestic dogs, feral dogs are highly social living in packs or groups year round in most cases (Daniels & Bekoff, 1989; Green & Gipson, 1994). In our study area, we only detected isolated dog's tracks. Additionally, camera-trapping studies conducted inside DNP during the same period detected only six dogs, all of which were found near human settlements and identified as domestic animals based on their external physical appearance (personal observ.).

Additionally, the occurrence of dog tracks restricted to the DNP edge and the low number of tracks detected far away from these reserve's edges supports the idea that the presence of domestic dogs at Doñana may be exacerbating the anthropogenic edge effect associated with its border areas.

Some previous authors have also reported a higher occurrence of domestic dogs near the edges of natural reserves compared to their interiors (Butler & du Toit, 2004; Srbek-Araujo & Chiarello, 2008; Lacerda *et al*., 2009; Marks & Duncan, 2009). In this sense, domestic dogs could be generally considered as human-derived edge effect at protected areas. The direct threats of domestic dogs to wildlife may therefore not spread throughout the entire protected area or along the entire edge length reaching its maximum near the anthropogenic border areas.

Edge effects can be important in the dynamics of populations living in fragmented landscapes because they may affect key population parameters, such as survival and reproduction (Murcia, 1995; Noss & Csuti, 1997). The peripheries of reserves thus function as population sinks (Revilla *et al.*, 2001) and the resulting edge effect can cause the decline or the extinction of protected carnivore populations (Woodroffe & Ginsberg, 1998). The higher occurrence of dogs in these border areas due to human presence in the surrounding matrix might exacerbate this effect.

Nevertheless, although domestic dogs rarely leave the vicinity of human dwellings (Vanak & Gompper, 2009*a*, Butler & du Toit, 2002) and appear to exhibit a range mainly limited to reserves' borders, their daily activity pattern may involve free-ranging that can bring them into contact with wildlife, especially when their movements are not confined to a proscribed outdoor area (Butler *et al*., 2004; Vanak, 2008).

Diseases from dogs that affect wild species (e.g. Woodroffe & Ginsberg, 1999, Cleaveland *et al.*, 2000) could be transmitted across the border of reserves worsen therefore the direct edge effects represented by domestic dogs in protected areas (i.e. the eventual predation and displacement of some species near the park border). In consequence, domestic dogs maintaining highly virulent, multi-host pathogens can induce mortality to wild carnivores owing to interspecific disease transmission between susceptible wild carnivores in the community even when the wildlife population of interest may never have contact with them.

DNP houses one of the last metapopulation of the most globally endangered felid species, the Iberian lynx (*Lynx pardinus*) (Palomares *et al.*, 2011) so dogs living or spending time inside the area come into contact with this wild endangered carnivore posing a serious risk for its conservation (Ferreras *et al*., 1992; Meli *et al*., 2009 and 2010; Millán *et al.*, 2009*a* and 2009*b*).

Domestic dogs are present in large numbers in urban, suburban and rural areas, so, due to their high numbers, they can have a substantial impact on wildlife, even when they do not need to hunt to survive.

This situation forms a complicated scenario for conservation biologists especially in conservation areas with endangered endemic carnivore populations and/or those where reserve size is too small in relation to the scale of the species' movement. There is a huge demand for more knowledge about and experience with this type of situation, in order to help prevent or diminish the impacts on native fauna in natural reserves.

Conclusions and management implications

Domestic dogs in DNP and in the surrounding matrix can considerably diminish the reserve's effectiveness in conserving wildlife. The rapid urbanization process close to conservation units and the growth of domestic dog populations is an increasing worldwide conservation. Thus, transborder conservation measures must be implemented in the protected areas.

In the specific case of DNP, controlling the dog populations is urgent and key for the wildlife protection in this national park. The detection of dog tracks at DNP was dependent on the presence of people and consequently on the resources they provide such that the potential direct effects of dogs on wildlife may be stronger on these anthropogenic boundaries. Management of domestic dogs in protected areas where feral dogs' populations are not established may therefore be focused at borders and neighbourhoods close to human dwellings. We suggest that control measures must include the restriction of domestic dog's free-roaming activity through local public awareness focusing on responsible ownership and biodiversity conservation, the removal of un-owned dogs through systematic campaigns on reserve boundaries near human settlements, as well as strengthening of pet policies.

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Table 1. Selection results from logistic regression models investigating the effects of anthropogenic, habitat and a combination of all variables on detection of dog tracks at DNP. For the top models, we report the small sample-size-adjusted Akaike's information criteria (AIC_c), the difference in AIC_c between each model with the lowest AIC_c (ΔAIC_c) and the AIC_c weight (w_i).

Model code	**Deviance**	**AIC_c**	**ΔAIC_c**	**w_i**
0. *Null model*	139.210	121.107	12.939	0.000
Anthropogenic				
1. *D_ANT, Hum, Rain*	100.170	108.168	0.000	0.276
2. *D_NAT, D_ANT, D_HOU, Hum, Rain*	97.470	109.469	1.301	0.144
3. *D_NAT, D_ANT, Hum, Rain*	98.240	108.242	0.074	0.266
4. *D_ANT, D_HOU, Hum, Rain*	99.750	109.747	1.579	0.125
Habitat				
5. *Pt, Hum, Rain*	112.970	120.971	12.803	0.000
6. *Veg, Hum, Rain*	106.720	122.265	14.097	0.000
7. *Pt, Veg, Hum, Rain*	110.900	122.897	14.729	0.000
Global				
8. *D_NAT, D_ANT, D_HOU, Pt, Hum, Rain*	97.950	111.953	3.785	0.042
9. *D_NAT, D_ANT, Pt, Hum, Rain*	98.850	110.853	2.685	0.072
10. *D_ANT, Pt, Hum, Rain*	100.810	110.811	2.643	0.074

FIGURES

Figure 1. Study area defined by the Doñana National Park site and the surrounding anthropogenic area. Dog tracks detected during track counts in 2×2 km^2 cell grids between November 2007 and April 2009 are shown below in detail.

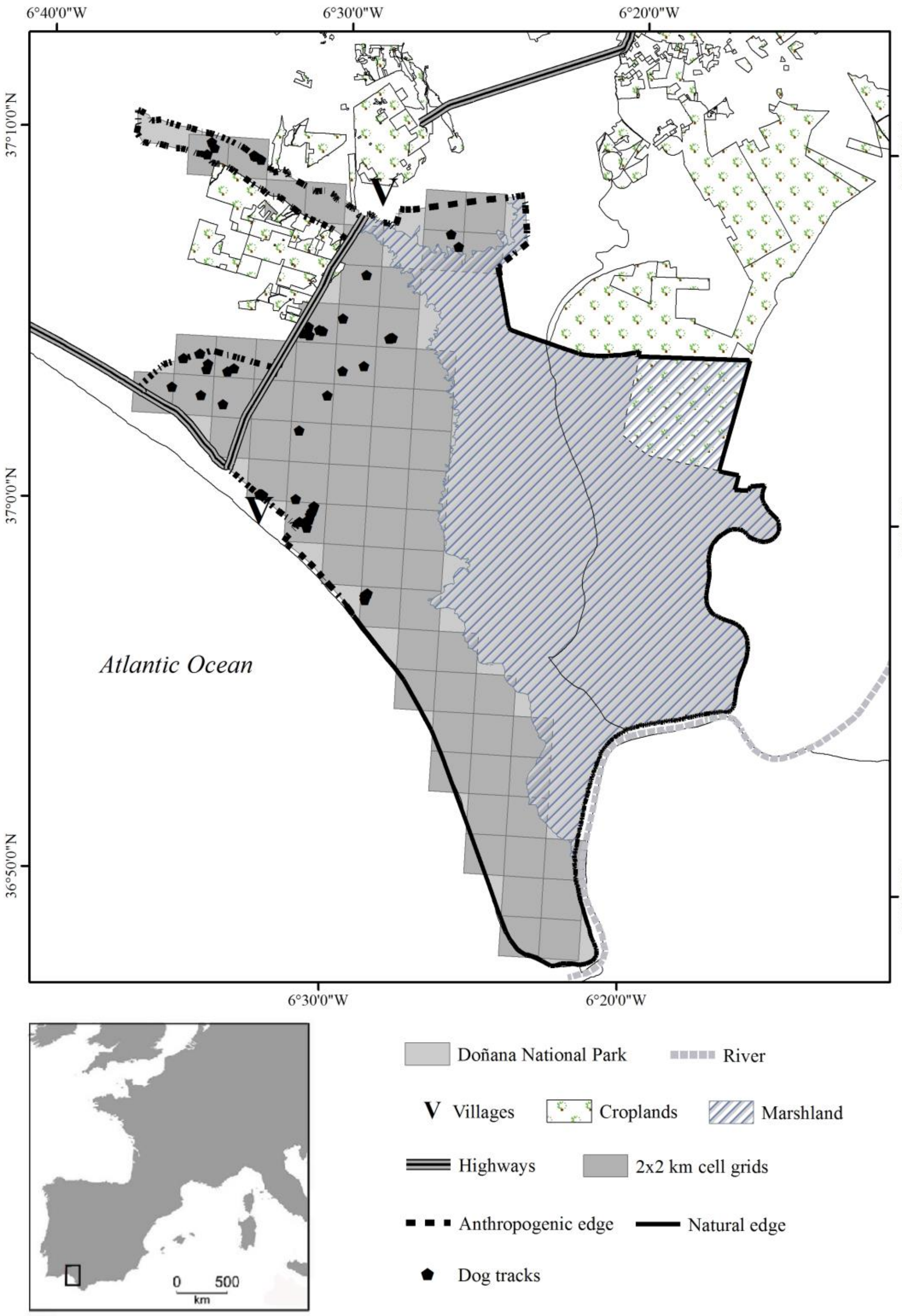

Figure 2. Probability of domestic dog tracks' detectability as a function of distance to the anthropogenic edge of DNP during the wet seasons of 2007-08 and 2008-09.