

Social perception of the presence of free-ranging dogs and cats in green areas of a Neotropical city

Rafael Flores-Peredo^{1,*} , Rocío Angélica Mendoza-Viveros¹ and Isac Mella-Méndez¹

ABSTRACT

Social perception of dogs and cats in urban green areas (UGAs) is a controversial issue. Our objective was to determine social perceptions regarding the presence of free-ranging dogs and cats in the UGA of the city of Xalapa, in Veracruz, Mexico, considering human sociodemographic variables. Between January and September 2019, we surveyed 480 residents using a questionnaire with binary responses and a Likert scale. The survey assessed perceptions about dogs and cats using urban green areas as shelter, breeding sites, and for predation on wildlife. It also evaluated the perceived nuisance associated with excreta and with the high abundance of free-ranging dogs and cats in streets and UGAs. In addition, we examined respondents' opinions on mass-sterilization strategies and the imposition of fines for irresponsible ownership. Our results showed that male semi-owners of the animals with no university education are most in agreement with these animals using the UGA for shelter, while semi-owners with no university education of the zones of high and medium socioeconomic status are those most in agreement with the dogs and cats breeding in the UGA. Most of the respondents were against the dogs and cats preying on wildlife, defecating in the streets and generating a nuisance through their high abundance. These results show that the social perception of free-ranging dogs and cats is somewhat complex and is strongly associated with sociodemographic variables, which are important to the design of effective management strategies and raising awareness among each demographic group.

Keywords: Exotic species, pets, Responsible pet ownership, urban areas, urban wildlife.

¹ Instituto de Investigaciones Forestales Universidad Veracruzana, Parque Ecológico "El Haya", Carretera Antigua a Coatepec, 91073 Xalapa-Enríquez, Ver, México.

* Corresponding author ✉. E-mail address: RFP (peredofr@gmail.com), RAMV (rocioangelica12@hotmail.com), IMM (isac.mella@gmail.com)

SIGNIFICANCE STATEMENT

Populations of dogs and cats in Neotropical cities are very high, but there is little knowledge about the social perception of their presence in urban green areas (UGAs). In our original research we evaluated the social perception of the presence of free-ranging dogs and cats in UGAs of Xalapa, Veracruz, Mexico, and considered human sociodemographic variables such as sex, educational level, socioeconomic status and type of ownership. We documented that semi-owners without a university education are more likely to agree that dogs and cats use UGAs as refuge, as breeding sites, that they prey on wildlife, and that they roam and defecate in streets and public areas. Our findings highlight that social perceptions of the impact of dogs and cats on wildlife and the environment demand a focused and integrated approach, as they are closely linked to sociodemographic variables that are essential for designing effective management strategies and targeted awareness campaigns for each social group.

INTRODUCTION

Dogs (*Canis lupus familiaris*) and cats (*Felis silvestris catus*) are the most widely distributed companion animals worldwide, with global estimates ranging from 600 to 1000 million individuals (Gompper 2014; Spotte 2014). Despite their role as domestic companions, nearly 75% of these animals are estimated to roam freely across natural, suburban, and urban environments, whether owned, stray, or feral (Spotte 2014). The presence of free-ranging dogs and cats in cities is often regarded as problematic due to the ecological and social risks they pose (Mella-Méndez *et al.* 2022). At the same time, their precarious living conditions—marked by hunger, disease, and abandonment—can elicit compassion from citizens. This ambivalence in social perception frequently motivates actions such as food provisioning in the streets, rescue initiatives, and participation in sterilization campaigns or other control strategies (Changrani-Rastogi and Thakur 2023).

Urban green areas (UGAs) are particularly relevant in this context, as they function both as reservoirs of biodiversity and as spaces for human recreation, while also being frequently used by free-ranging pets for shelter, breeding, and foraging. The ecological impacts of dogs and cats in UGAs and surrounding urban habitats are well documented: they are efficient predators of native vertebrates (Doherty *et al.* 2016; Mella-Méndez *et al.* 2022), vectors of pathogens and zoonotic diseases (Goldstein and Abrahamian 2015; Ghasemzadeh and Namazi 2015), competitors with native species for space and resources (Mella-Méndez *et al.* 2019b), capable of harassing or injuring wildlife (Vanak *et al.* 2010), and of displacing species from their natural habitats (Van Heezik *et al.* 2010; Spotte 2014). Moreover, UGAs and public spaces often serve as breeding grounds for these animals (Gehrt *et al.* 2013; Mella-Méndez *et al.* 2019a). From a social perspective, high densities of free-ranging dogs and cats generate several challenges, including the deposition of excreta in public areas, which citizens perceive in different ways. Many regard it as a nuisance that com-

promises public health and hygiene, whereas others consider it a potential source of nutrients for urban vegetation. This diversity of opinions should be carefully considered when assessing public attitudes and developing management strategies (De Frenne *et al.* 2022).

Globally, the magnitude of this impact is considerable: dogs and cats are estimated to negatively affect 156 and 430 species, respectively, with dogs implicated in the extinction of nine species and cats in the extinction of 63 species (Doherty *et al.* 2016). From a social perspective, high densities of free-ranging dogs and cats exacerbate public health and safety issues, being associated with large accumulations of excreta in public areas (Baker *et al.* 2010), traffic accidents (Canal *et al.* 2018; Conroy *et al.* 2018), bites and potential disease transmission to pedestrians (Ghasemzadeh and Namazi 2015; Goldstein and Abrahamian 2015), as well as nuisances such as nocturnal vocalizations and garbage scattering (Baker *et al.* 2010). In response to these ecological and social challenges, several management approaches have been implemented worldwide, including large-scale sterilization programs (Downes *et al.* 2009), adoption and rehoming initiatives (Holland 2019), and legal sanctions for abandonment or inadequate animal care (Ortega-Peñafiel *et al.* 2021), all aimed at reducing free-ranging populations and mitigating their negative impacts.

The social perception of free-living dogs and cats remains a controversial and complex issue (Weston *et al.* 2014; Shuttlewood *et al.* 2016). Although the ecological impacts of these animals are increasingly documented, fewer studies have examined the social dimensions that shape management outcomes, particularly in the case of urban cats (Deak *et al.* 2019). Ownership status is one of the most relevant factors influencing attitudes toward dogs and cats. For example, pet owners, defined as those who provide regular food, shelter, and medical care, generally exhibit strong attachment to their animals, consider them family members, and exercise greater control over their roaming behavior (Cohen 2002). In contrast, semi-owners, defined as individuals who provide occasional food with-

out establishing a socio-affective bond or assuming formal responsibility, tend to show less concern for animal welfare and reduced control, as they do not perceive these animals as their property (Toukhsati *et al.* 2007; Toukhsati *et al.* 2012; Zito *et al.* 2015). Beyond ownership, sociodemographic variables also play a key role. Gender, for instance, has been linked to differences in attitudes: in Ireland, women were shown to be more compassionate and humane toward stray dogs and cats, expressing more positive perceptions and engaging more actively in rescue and shelter activities (Downes *et al.* 2009; Gaarder 2011). Similarly, education level influences environmental awareness, with university-educated individuals more likely to recognize the ecological and sanitary impacts of free-ranging pets (Sinclair *et al.* 2022; Smith *et al.* 2022; Changrani-Rastogi and Thakur 2023). Socioeconomic status has also consistently emerged as a strong predictor of both the ability to provide adequate care for pets and attitudes toward free-roaming animals (Jacobson and Chang 2018). In contexts marked by poverty and inequality, where access to veterinary services and adequate housing is limited, animal welfare is frequently compromised and abandonment becomes a common practice (Arrington and Markarian 2017; Smith *et al.* 2022). Collectively, these findings demonstrate that social perception of dogs and cats is not homogeneous but is shaped by a multidimensional interplay of variables, including ownership type, gender, education, and socioeconomic conditions, all of which must be considered when designing comprehensive management strategies (Shuttlewood *et al.* 2016).

Although social perceptions of free-ranging dogs and cats have been widely studied in developed countries, little research has focused on Neotropical cities (Deak *et al.* 2019). This gap is concerning, as the region not only harbors large populations of free-ranging dogs and cats (Mota-Rojas *et al.* 2021) but also sustains exceptional biodiversity, including numerous threatened vertebrate species that may be negatively affected in both natural and urban environments (Mella-Méndez *et al.* 2022). Moreover, many Neotropical countries experience rapid demographic growth combined with extreme poverty, conditions that frequently promote pet abandonment and are often reinforced by limited public knowledge, education, and awareness of animal welfare (Mota-Rojas *et al.* 2021). Given these ecological and social challenges, documenting social perceptions of free-ranging dogs and cats in urban green areas (UGAs) represents a research priority to inform management, environmental education, and policy strategies aimed at controlling and managing these animals (Gompper, 2014; Mella-Méndez *et al.* 2022).

The city of Xalapa, Veracruz, Mexico, provides a relevant case study. Located in the Neotropical re-

gion, Xalapa is recognized for its 397 urban green areas (UGAs), which host a wide diversity of native vertebrate species (Carmona-Ortega *et al.* 2022). However, the presence of free-roaming dogs and cats in these areas is increasing (Mella-Méndez *et al.* 2019a). Documented impacts on wildlife include cats preying on at least 64 taxa—93.5% of which are native species—and dogs overlapping in activity patterns with five medium-sized wild mammals (Mella-Méndez *et al.* 2019b). Understanding public attitudes is critical to explain these high densities and to design comprehensive management strategies for Neotropical cities facing similar challenges. Accordingly, this study aimed to assess the perceptions and attitudes of Xalapa's residents toward free-roaming dogs and cats in urban green areas (UGAs), considering sociodemographic factors such as ownership type, sex, education level, and socioeconomic status. Specifically, we evaluated residents' perceptions regarding the use of UGAs by dogs and cats, their impacts on wildlife, the deposition of their excreta, and public support for the establishment of control and management measures such as sterilization, adoption, fines, and legal proceedings. We predicted that women, pet owners, university-educated residents, and higher socioeconomic groups would express more negative attitudes toward these animals and greater support for management and control actions.

MATERIAL AND METHODS

Study area

The study area was the city of Xalapa (19°31'55" N; 96°54'33" W; 1220–1557 m.a.s.l.), located in the mountainous central region of Veracruz, Mexico. Its climate is classified as C(fm), corresponding to a humid temperate type with abundant summer rainfall (García 1981) and is characterized as temperate with a mean temperature of 18 °C and mean annual precipitation of 1500 mm (Pereyra-Díaz *et al.* 2000). To categorize the survey respondents according to their socioeconomic status, the mean cost per square meter of land and type of dwelling was determined for each neighborhood using data from the municipal land registry office (INEGI 2010). The research focused on neighborhoods of three different costs per socioeconomic stratum, with zone 1 (low socioeconomic status) comprising the neighborhoods El Moral, Vasconcelos, and Revolución; zone 2 (medium socioeconomic status) comprising Xalapa 2000, Jardines de Xalapa, and Agua Santa; and zone 3 (high socioeconomic status) comprising Las Ánimas, Lomas del Tejar, and Coapexpan (Figure 1). Xalapa is considered one of the cities with the highest proportion of UGAs per inhabitant in Neotropics (16.91 m² per inhabitant), with around

397 UGAs ranging from 10 m² to 527.62 ha in size that together form an area of 929.85 hectares (Carmona-Ortega *et al.* 2022). The zone of low socioeconomic level has an average of nine UGAs, while the area of medium socioeconomic level has four and the zone of high socioeconomic level has 12 UGAs. The majority of UGAs have no monitoring of the visitors who enter, or any strict control of the dogs and cats that roam in these sites, although previous studies have determined their abundance and negative effect on the wild fauna that is present (Mella-Méndez *et al.* 2019a).

Data collection

A survey modified from Lord (2008) and Zito *et al.* (2015) was applied to obtain demographic data pertaining to the respondents, as well as to assess their knowledge, social perception, and opinions regarding management policies for free-roaming dogs and cats. This instrument comprised five binary (yes/no) questions with an open response option and two statements for evaluation on a five-point Likert scale: strongly agree, agree, neutral, disagree, strongly disagree (Add File 1). The survey was directed to individuals >18 years of age during the period January-September 2019. We did not consider the analysis of differences in responses between dog and cat owners necessary since the majority of these people (72%) indicated having custody of both types of pets. We also excluded non-owners to focus on the opinions of individuals with a direct connection to their pets. A total of 827 people were invited to participate, of which 480 individuals accepted (58.04% success). The respondents came from each of the three socioeconomic strata, and there was equal representation of the different demographic variables evaluated (Table 1).

Statistical analysis

Cronbach's alpha was used to validate the first two responses obtained under the Likert scale. This coefficient takes values from 0 to 1, in which a value of 0.7 is considered acceptable (Zar 1999). The independent demographic variables considered in our model were socio-economic status (low/middle/high), ownership type (owner/semi-owner), sex (male/female), and educational level (with/without university education). To test the effect of these variables, and their interactions, ordinal logistic regression was used, considering an ordinal multinomial distribution for the questions with responses on a Likert scale, with the "nnet" package version 7.3-12 of R (Ripley *et al.* 2016), as well as a binomial logistic regression for questions with a binary (yes/no) answer, with the glm function of the "ISLR" package (James 2017). A multicollinearity analysis was performed to verify that none of the

predictor variables were correlated, using Variance Inflation Factors (VIF) from the R package "Car". The "dredge" function of the "MuMIn" package was used to define the model that best explained the data (Barton 2018). This procedure evaluates the set of explanatory variables and all their possible combinations using a classification based on the Akaike information criterion (AIC) (Burnham and Anderson 2004). The models shown are those that obtained ΔAIC scores < 2 (Burnham and Anderson 2004). The goodness of fit of the models was evaluated by calculating McFadden's R-Squared with the "ISLR" package (James *et al.* 2017). All tests considered a significant level value of 95% ($\alpha < 0.05$). Additionally, descriptive mosaic plots were constructed using the VCD package in R to represent the frequency distribution of respondents across the survey questions. In these plots, the width of each column indicates the relative number of individuals in each category, such as ownership type or education level, while the height of the subdivisions within each column reflects the distribution of responses (strongly agree, agree, neutral, disagree, strongly disagree). This visualization approach enables the simultaneous interpretation of group size and response variability, providing a clearer overview of the data structure.

RESULTS

UGAs as shelter sites for dogs and cats

We documented a significant effect of the ownership factor ($X_i^2 = 17.70$; DF = 1; P = 0.003), where the semi-owners were those who expressed most agreement (that dogs and cats should use the UGAs as shelter sites (Figure 2, Table 2).

UGAs as breeding sites for dogs and cats

We recorded a highly significant effect of the factor level of university studies ($X_i^2 = 11.3$; DF = 1; P = 0.0008), where individuals with university studies were less in support of the use of UGAs by dogs and cats as breeding sites (Figure 3, Table 2).

Predation of wildlife by dogs and cats, excrement in UGAs, free-roaming, imposition of fines, and execution of sterilization campaigns

Most respondents were not in favor of pets preying on wildlife (n = 314, 65.4%), defecating on public roads and in the UGAs (n = 378, 78.7%), or roaming freely in the streets (n = 303, 63.1%), but they were almost unanimously in agreement that pet owners should pay fines for irresponsible pet ownership (n

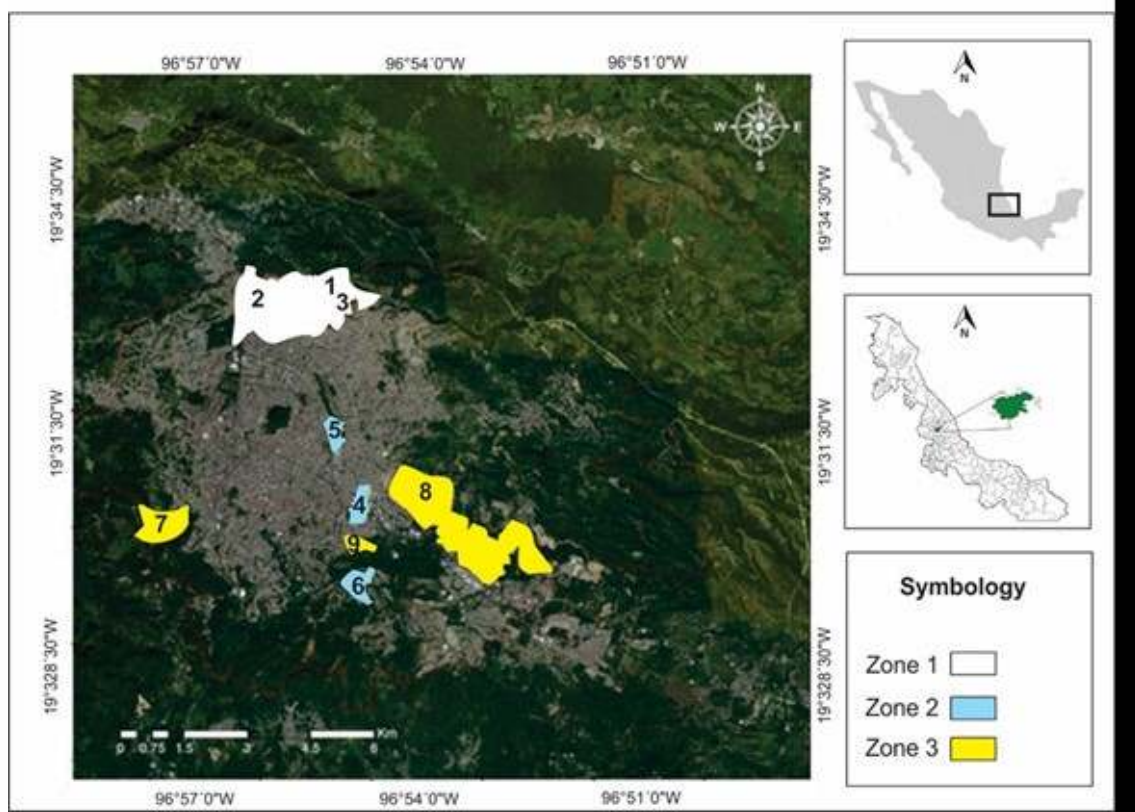


Figure 1. Location of the three zones in which the survey was applied: Zone 1: low socioeconomic status, neighborhoods El moral (1), Revolución (2) and Vasconcelos (3); Zone 2: medium socioeconomic status, comprising the neighborhoods Agua Santa (4), Jardines de Xalapa (5), and Xalapa 2000 (6); and Zone 3: high socioeconomic status, comprising the neighborhoods Coapexpan (7), Las Ánimas (8), and Lomas del Tejar (9).

= 471, 98.1%) and that pet sterilization campaigns should be encouraged ($n = 478, 99.5\%$) (Figure 4). The results show that some predictors had a significant effect on some responses. In the perception of predation of wildlife by dogs and cats, we recorded an interaction between ownership type and educational level (Z value = -2.086; $P = 0.037$) (Figure 5a); semi-owners without university education were more in agreement that pets should prey on wildlife (Table 2). Likewise, an effect of ownership type was recorded ($Z = 2.006$; $P = 0.0449$) (Figure 5b); semi-owners were more in agreement that pets should defecate in public areas (Table 2), while people without a university education were more in agreement that pets should roam freely on the streets ($Z = -2.168$; $P = 0.0302$) (Figure 5c). There was no association between any predictive factor regarding the implementation of sterilization campaigns or the application of fines to irresponsible owners.

Table 1. Demographic structure of the respondents in the study for each of the three socioeconomic strata (low, medium and high).

Ownership type	Sex	Educational level	Number of respondents
Owner	Male	University	20
	Female	University	20
	Male	No university	20
	Female	No university	20
Semi-owner	Male	University	20
	Female	University	20
	Male	No university	20
	Female	No university	20
Total			160

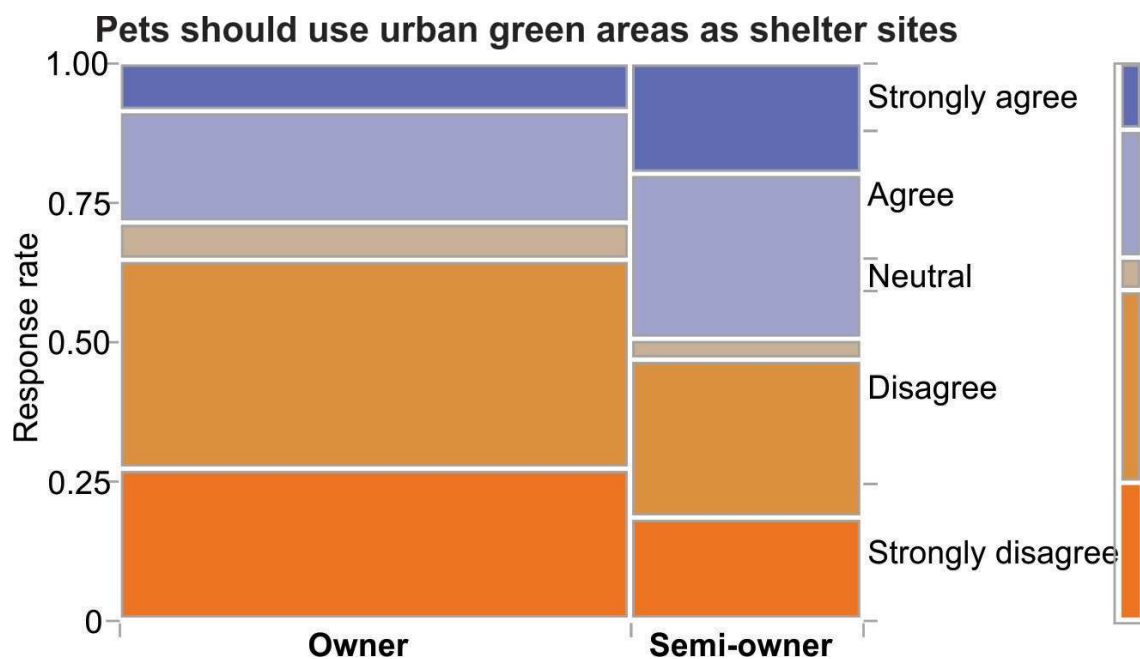


Figure 2. Mosaic plot is about social perception of owners and semi-owners with regarding the use of UGAs as shelter by dogs and cats. The width of each column represents the relative number of individuals in each category (owner or semi-owner), while the height of the subdivisions within the columns indicates the proportion of responses (strongly agree, agree, neutral, disagree, strongly disagree).

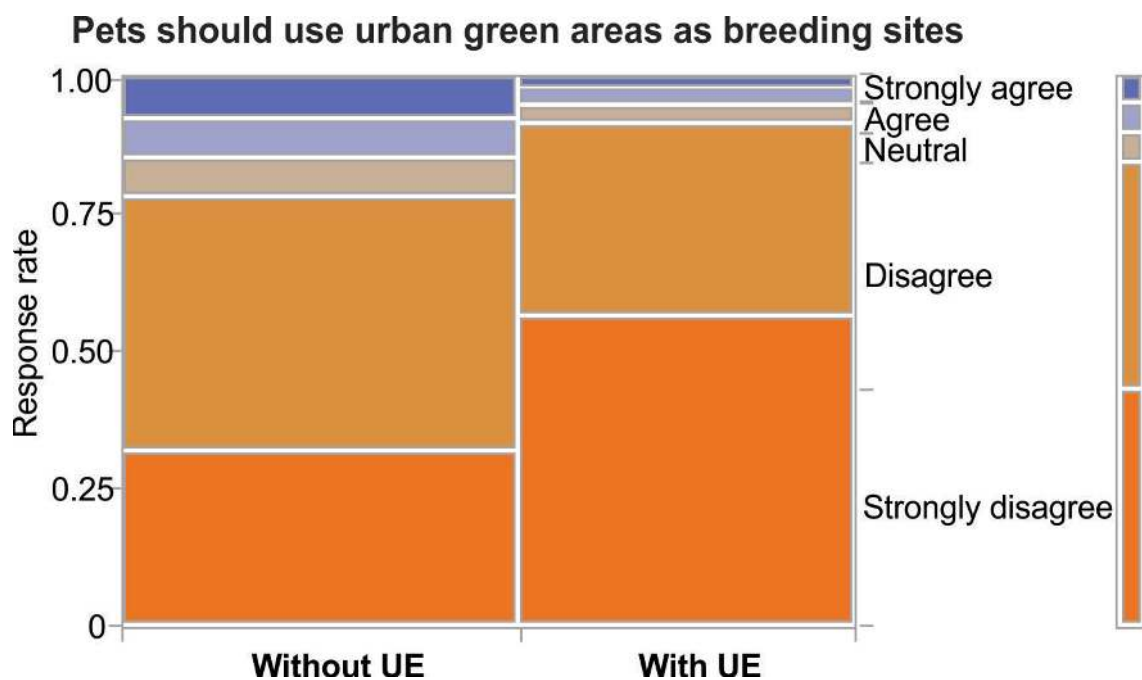


Figure 3. Mosaic plot is about social perception of respondents with and without university education (UE) regarding the use of UGAs by dogs and cats as breeding sites. The width of each column corresponds to the relative number of individuals in each category (without university education/with university education), while the height of the subdivisions within the columns reflects the proportion of responses (strongly agree, agree, neutral, disagree, strongly disagree).

Table 2. Values obtained from the significant models with Akaike distribution that best explain the results of the items that had an effect of the predictors, considering ΔAIC scores < 2 (Burnham and Anderson 2004).

Item (Perceptions)	Model	df	logLik	AICc	Δ AIC	AIC weight	McFadden's R ²
1. "Dogs and cats should use urban green areas as shelter sites"	Ownership type	5	-374.774	761.9	0	0.391	0.383
	Ownership type + Educational level	6	-374.553	763.5	1.67	0.17	0.181
2. "Dogs and cats should use urban green areas as breeding sites"	Educational level	5	-300.59	611.4	0	0.378	0.301
	Ownership type + Educational level	6	-299886	612.1	0.69	0.268	0.178
3. "Do you agree that dogs and cats should prey on wildlife in urban green areas?"	Ownership type + Educational level	3	-163.504	335.2	0	0.344	0.347
	Ownership type	3	-165.598	335.7	0.52	0.165	0.148
	educational level	2	-165.197	336.5	1.32	0.158	0.132
	Ownership type + Socio-economic status	6	-161.804	335.9	1.78	0.054	0.127
4. "Do you agree that dogs and cats should defecate on public roads and in urban green areas?"	Ownership type	2	-129.502	267.2	0	0.25	0.28
	Ownership type + Socio-economic status	4	-132373	268.8	1.63	0.111	0.13
	Socio-economic status	3	-131.371	268.8	1.67	0.108	0.02
	Ownership type + Socio-economic status + Educational level	5	-129.409	269.1	1.89	0.097	0.03
	Educational level	2	-169.109	342.3	0	0.462	0.212
5. "Do you agree that dogs and cats should roam freely in the streets?"	Ownership type + Educational level	3	-168.501	343.1	0.83	0.283	0.15
	Socio-economic status + Educational level	4	-164.19	338.6	1.06	0.167	0.03
	Ownership type + Socio-economic status + Educational level	5	-163.345	338.3	1.22	0.1	0.04

DISCUSSION

Our findings indicate that among the four sociodemographic variables initially hypothesized—ownership type, sex, socioeconomic status, and education level—only ownership type and university education significantly influenced respondents' perceptions. Semi-owners without university education were more likely to tolerate or even support the use of UGAs and streets by free-ranging dogs and cats for refuge, reproduction, roaming, defecation, and predation on wildlife. These patterns underscore the role of responsibility and knowledge in shaping public attitudes, highlighting the importance of demographic factors in explaining variations in social perception. While previous studies in developed countries have emphasized similar dimensions, evidence from the Neotropical region remains scarce, despite being one of the areas most affected by the presence of free-ranging dogs and cats (Mota-Rojas *et al.* 2021). By examining each demographic factor, our study helps to fill this gap and provides insights that are relevant for designing management strategies tailored to local social contexts. In the following sections, we discuss each of the demographic variables separately.

Ownership type (Owners vs. Semi-owners)

Our results demonstrate that ownership type is a predictor associated with attitudes and perceptions toward free-ranging dogs and cats. Semi-owners were more likely to tolerate dogs and cats roaming without restriction, defecating in public spaces, and preying on wildlife, as well as to accept their use of UGAs for shelter and breeding sites. These findings are consistent with previous studies that document weaker socio-affective bonds and limited oversight among semi-owners (Toukhsati *et al.* 2012; Zito *et al.* 2015). For example, in Australia, about one-third of shelter-admitted cats originate from semi-ownership contexts, illustrating how limited social responsibility can inflate free-ranging populations and intensify their ecological impacts (Zito *et al.* 2015). Semi-owners frequently lack consistent control over animals' movements, granting them greater freedom to forage and reproduce (Toukhsati *et al.* 2012). At the same time, many justify this limited care through empathy or moral compassion, perceiving UGAs as safer alternatives to the streets. However, this dynamic creates “subsidized” subpopulations in which animals receive sufficient resources to survive and reproduce while remaining largely unmanaged, thereby facilitating greater reproduction, disease transmission, and predation or harassment of wildlife (Baker *et al.* 2010). A study conducted in Brazil further showed that

free-roaming dogs tend to cluster significantly closer to community feeders—sites where people intentionally leave food—underscoring how human-provided resources sustain these unmanaged subpopulations (De Melo *et al.* 2023).

Systematic reviews of dog and cat population management consistently indicate that sterilization and vaccination programs are most effective when combined with responsible ownership policies (Taylor *et al.* 2017; Smith *et al.* 2019). In low-income urban environments, sterilization has successfully reduced populations of these animals, but only when paired with community engagement and ownership formalization (Taylor *et al.* 2017). In this context, our finding that semi-owners display greater permissiveness toward socioecologically harmful behaviors underscores the need for targeted interventions. These should include: (i) legally defining and recognizing semi-ownership within local regulations, (ii) reducing legal barriers to the registration and sterilization of informally cared-for animals, and (iii) developing tailored messages for semi-owners that reframe feeding practices in UGAs and streets as a shared responsibility involving integrated health, sterilization, and adequate containment.

Education level (with vs. without university education)

Education showed to be an important factor shaped public perceptions of issues related to cat and dog breeding in uncontrolled green areas (UGAs), roaming, and defecation in public spaces. Respondents with university-level education were less inclined to tolerate UGAs as breeding sites and expressed stronger opposition toward behaviors perceived as detrimental to public health or ecological integrity. These patterns are congruent with previous findings indicating that higher education is often associated with heightened awareness of zoonotic risks, environmental effects, and animal-welfare standards (Sinclair *et al.* 2022; Smith *et al.* 2022).

Individuals with university education may possess a greater capacity to recognize the indirect consequences of free-ranging pets, including their potential role in predation on native vertebrates, disruption of ecological interactions, and challenges for adequate sanitation and urban governance (Doherty *et al.* 2016; Mella-Méndez *et al.* 2022). This expanded environmental literacy, associated with a stronger orientation toward precautionary principles, can translate into more critical evaluations on practices that entail ecological or sanitary risks (Sullivan *et al.* 2022). Furthermore, higher education often also nurtures sensitivity to ethical and animal welfare considerations, reinforcing the view that uncontrolled reproduction or unsupervised roaming of companion animals can gen-

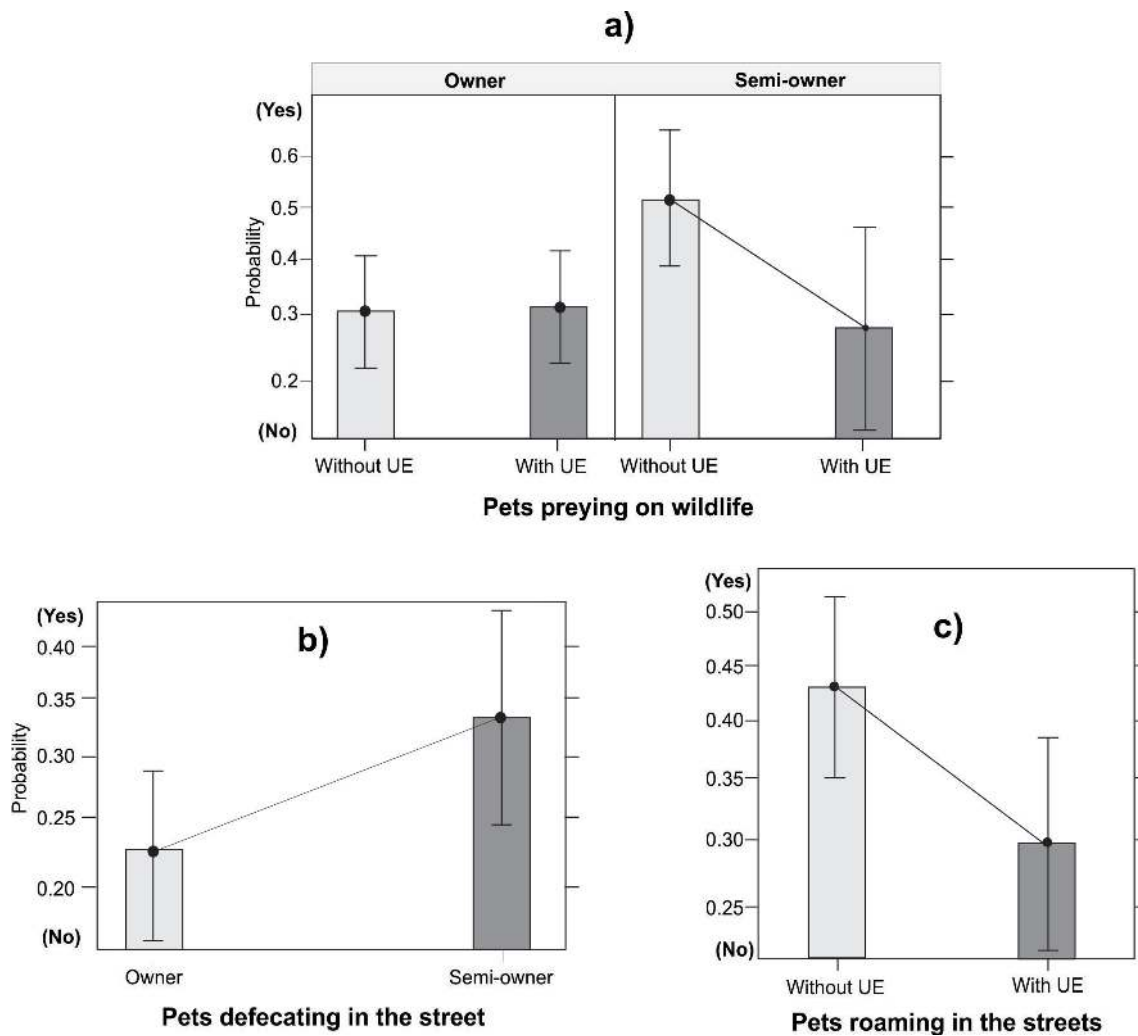


Figure 4. Social perception regarding the fact that dogs and cats preying on wildlife, deposit excreta and roam freely in the street, the imposition of fines for irresponsible ownership, and development of sterilization campaigns.

erate undesirable outcomes not only for those nature and urban ecosystems but also for the animals themselves (Shuttlewood *et al.* 2016).

Importantly, the differences observed are unlikely to reflect highly specialized technical knowledge in the interviewees, such as demographic data necessary for the sterilization campaign. For example, empirical and theoretical research underscores that effective management of free-roaming cats and dogs populations requires intensive and spatially contiguous sterilization efforts (Gunther *et al.* 2022). Specifically, maintaining sterilization above approximately 70% of cats and dogs' population is often necessary to achieve their population decline and reduce successfully their reproductive rates (McCarthy *et al.* 2013; Boone *et al.* 2019; Gunther *et al.* 2022). Therefore, these procedures can be linked to the cognitive and attitudinal

dimensions of higher education.

Sex (Male vs. Female)

Although sex did not emerge as a significant predictor in our models, a critical literature review reveals potential cultural nuances. Globally, women often report higher concern for animal welfare and show greater engagement with humane actions (Gaarder 2011). For example, in Ireland, women were shown to be more compassionate and humane toward stray dogs and cats, expressing more positive perceptions and engaging more actively in rescue and shelter activities (Downes *et al.* 2009). Similarly, in the context of feral cat colony management conflicts, gender differences were also evident, with women tending to support non-lethal management strategies more frequently than men (Peterson *et al.* 2012). In Xalapa,

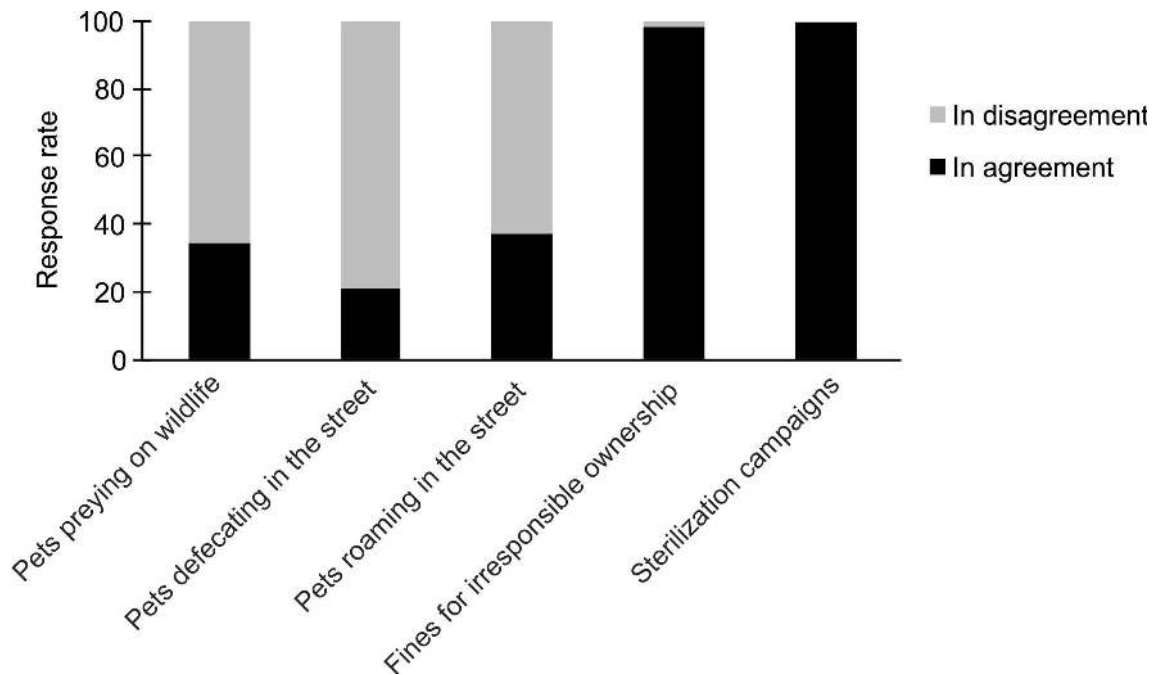


Figure 5. Comparison of the response probability of the respondents regarding whether it is acceptable that (a) pets preying on wildlife, (b) pets defecating in the street and the UGAs, and (c) pets roaming freely in the streets and in the UGAs.

the absence of gender differences may reflect equal exposure to free-roaming pet issues across genders, being their care and management roles also equitable. However, recognizing that women may still be more active in grassroots engagement, actions programs could benefit from gender-inclusive leadership, as well as for volunteer recruitment strategies (Downes *et al.* 2009).

Socioeconomic Status (Low, Medium, High)

Our data revealed no significant differences in perceptions toward free-roaming dogs and cats across socioeconomic strata. This mirrors findings Jacobson and Chang (2018) from urban sceneries studies were physical proximity to animals, rather than socioeconomic status, moderated residents' attitudes. In urban contexts, frequent encounters with domestic animals contribute to perceptions of these animals as common members of a family, reducing perceptual variability across different socioeconomic groups (Guilloux *et al.* 2018). This aligns with urban studies exploring environmental inequities. For example, in Santiago, Chile, researchers found that the density of free-roaming dogs was significantly higher in economically poor neighborhoods—yet this did not necessarily translate into more negative perceptions compared to wealthier areas. Instead, frequent day-to-day sightings appear to normalize their presence across social groups, poten-

tially equalizing social attitudes regardless of income level (Crespin and Contreras-Abarca 2024). This reinforces the idea that, in cities like Xalapa, factors such as daily coexistence with dogs and cats can homogenize perceptions regardless of differences across socioeconomic strata.

CONCLUSION AND RECOMMENDATIONS

Our findings highlight the need for a comprehensive approach that incorporates sociodemographic variables to ensure the effective management of stray dogs and cats within UGAs. Although in other regions from Australian and European continent various strategies are promoted, such as microchipping and mandatory pet registration by local councils, establishment of anti-abandonment rules, leash laws, and excrement collection policies (Morton *et al.* 2018; Smith *et al.* 2019) our findings also show that management in the cats and dogs management must be adapted to local contexts. Semi-owners, who in our study were more tolerant of roaming, breeding in UGAs, and other negative impacts, are a social key group for the dissemination and implementation of management strategies. Relying only on the imposition of fines, this could discourage the semi-owners participation and reduce the management programs success. Instead, strate-

gies should focus on: (i) amnesty-based registration for animals already under informal care, (ii) establishment of free and mobile sterilization and vaccination campaigns in low-income areas to reduce cost, and (iii) educational messages that frame feeding in UGAs as a responsibility which includes sterilization, vaccination, and the prohibition of free-roaming. Free health programs for dog and cat control that consider citizen participation have proven more effective than punitive or extermination measures (Taylor *et al.* 2017; Smith *et al.* 2019). However, it is necessary to strive for public policies that ensure efficient sterilization, since untreated areas can quickly repopulate sterilized zones (Kotzé *et al.* 2021). To address these risks, programs should use stages roll-outs that cover connected areas, monitor sterilization, vaccination, as well as abandonment rates, in turn create buffer zones around UGAs to prevent dog and cat recolonization (Boone *et al.* 2019; Gunther *et al.* 2022).

In UGAs, the management and control of dogs and cats require a combined approach. Responsible ownership practices—including confinement, sterilization, and vaccination in surrounding neighborhoods—should be paired with public education that discourages abandonment and feeding while explaining the ecological impacts of dogs and cats. In addition, the implementation of simple strategies such as efficient garbage collection, well-managed bins, and clear signage can further support these measures. Collectively, these actions can reduce wildlife predation and disturbance (Doherty *et al.* 2016; Mella-Méndez *et al.* 2022), lower fecal contamination and disease transmission risks (Goldstein and Abrahamian 2015; Ghasemzadeh and Namazi 2015), improve visitor experiences, and decrease conflicts between UGA users and animal advocates. In sum, a comprehensive management plan for dogs and cats in urban environments should safeguard public health and the ecological integrity of UGAs, while also accounting for the local sociodemographic contexts associated with them.

ACKNOWLEDGMENTS

Thanks go to the Consejo Nacional de Ciencia y Tecnología for grant number 901927, awarded to the second author to develop her postgraduate studies, and to the team at the Laboratorio de Ecología of the Instituto de Investigaciones Forestales for their support with the surveys and in the dissemination events at which the results of this project were shared.

DATA AVAILABILITY

The data used to support the findings of this study are available from the corresponding author upon rea-

sonable request.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

CONTRIBUTION STATEMENT

Conceived of the presented idea: RFP.
Carried out the experiment: RAMV.
Carried out the data analysis: IMM.
Wrote the first draft of the manuscript: RAMV.
Review and final write of the manuscript: RFP, IMM.
Supervision: RFP.

FUNDING DECLARATION

The authors received no financial support for the research, authorship, and/or publication of this article.

DISCLOSURE OF AI USE

The authors used ChatGPT (OpenAI, GPT-5 model) to refine language in the introduction and discussion. All AI-generated content was carefully reviewed, edited, and validated by the authors.

REFERENCES

- Arrington A, Markarian M (2018) **Serving pets in poverty: A new frontier for the animal welfare movement.** *Sustainable Development Law & Policy* 18:11.
- Baker PJ, Soulsbury CD, Iossa G, Harris S (2010) **Domestic cat (*Felis catus*) and domestic dog (*Canis familiaris*).** In: Gehrt SD, Riley SPD and Cypher BL (Eds) *Urban carnivores – ecology, conflict, and conservation.* Johns Hopkins University Press, Baltimore. pp. 157–172.
- Barton K (2018) Package ‘MuMIn’: **Multi-model Inference.** R Package, version 1.42.1 [<https://cran.r-project.org/web/packages/MuMIn/MuMIn.pdf>] Accessed 04 November 2024.
- Boone JD, Miller PS, Briggs JR, Benka VAW, Lawler DF, Slater M, Levy JK, Zawistowski S (2019) **A long-term lens: cumulative impacts of free-roaming cat management strategy and intensity on preventable cat mortalities.** *Frontiers in Veterinary Science* 6:238. doi: 10.3389/fvets.2019.00238.

- Burnham KP, Anderson DR (2004) **Multimodel inference.** *Sociological Methods & Research* 33:261–304. doi: [10.1177/0049124104268644](https://doi.org/10.1177/0049124104268644).
- Carmona-Ortega M, Falfán I, Lascurain-Rangel M, Benítez-Badillo G (2022) **Distribución espacial de las áreas verdes urbanas en Xalapa, México: un caso de inequidad.** *Sociedad y Ambiente* (25):1–32. doi: [10.31840/sya.vi25.2559](https://doi.org/10.31840/sya.vi25.2559).
- Changrani-Rastogi A, Thakur N (2023) **Attitudes towards urban stray cats and managing their population in India: a pilot study.** *Frontiers in Veterinary Science* 10. doi: [10.3389/fvets.2023.1274243](https://doi.org/10.3389/fvets.2023.1274243).
- Cohen SP (2002) **Can pets function as family members?** *Western Journal of Nursing Research* 24:621–638. doi: [10.1177/019394502320555386](https://doi.org/10.1177/019394502320555386).
- Crespin SJ, Contreras-Abarca R (2024) **Urban dog densities reveal environmental inequities in Santiago, Chile.** *Ambio* 53:941–950. doi: [10.1007/s13280-024-01984-y](https://doi.org/10.1007/s13280-024-01984-y).
- De Frenne P, Cougnon M, Janssens GPJ, Vangansbeke P (2022) **Nutrient fertilization by dogs in peri urban ecosystems.** *Ecological Solutions and Evidence* 3:(1). doi: [10.1002/2688-8319.12128](https://doi.org/10.1002/2688-8319.12128).
- De Melo SN, Alves MCGP, Paranhos NT, Mesquita FO, Beltrame LFS, Nogueira-Filho SLG (2023) **The influence of community feeders and commercial food outlets on the spatial distribution of free-roaming dogs—A photographic capture and recapture study.** *Animals* 13(5):824. doi: [10.3390/ani13050824](https://doi.org/10.3390/ani13050824).
- Deak BP, Ostendorf B, Taggart DA, Peacock DE, Bardsley DK (2019) **The significance of social perceptions in implementing successful feral cat management strategies: A Global Review.** *Animals* 9:617. doi: [10.3390/ani9090617](https://doi.org/10.3390/ani9090617).
- Doherty TS, Glen AS, Nimmo DG, Ritchie EG, Dickman CR (2016) **Invasive predators and global biodiversity loss.** *Proceedings of the National Academy of Sciences* 113:11261–11265. doi: [10.1073/pnas.1602480113](https://doi.org/10.1073/pnas.1602480113).
- Downes M, Canty MJ, More SJ (2009) **Demography of the pet dog and cat population on the island of Ireland and human factors influencing pet ownership.** *Preventive Veterinary Medicine* 92:140–149. doi: [10.1016/j.prevetmed.2009.07.005](https://doi.org/10.1016/j.prevetmed.2009.07.005).
- Gaarder E (2011) **Where the boys aren't: The predominance of women in animal rights activism.** *Feminist Formations* 23(2):54–76.
- García E (1981) **Modificaciones al sistema de clasificación climática de Köppen (para adaptarlo a las condiciones de la República Mexicana).** Instituto de Geografía, Universidad Nacional Autónoma de México, Ciudad de México, México.
- Gehrt SD, Wilson EC, Brown JL, Anchor C (2013) **Population ecology of free-roaming cats and interference competition by coyotes in urban parks.** *PLoS ONE* 8:e75718 doi: [10.1371/journal.pone.0075718](https://doi.org/10.1371/journal.pone.0075718).
- Ghasemzadeh I, Namazi S H (2015) **Review of bacterial and viral zoonotic infections transmitted by dogs.** *Journal of Medicine and Life* 8(4):1–5.
- Guilloux AG, Panachão LI, Alves AJ, Zetun CB, Cassenote AJ, Dias RA (2018) **Stray dogs in urban fragments: relation between population's perception of their presence and socio-demographic factors.** *Pesquisa Veterinária Brasileira*, 38(1):89–93. doi: [10.1590/1678-5150-pvb-4293](https://doi.org/10.1590/1678-5150-pvb-4293).
- Gunther I, Hawlena H, Azriel L, Gibor D, Berke O, Klement E (2022) **Reduction of free-roaming cat population requires high-intensity neutering in spatial contiguity to mitigate compensatory effects.** *Proceedings of the National Academy of Sciences of the United States of America* 12;119(15):e2119000119. doi: [10.1073/pnas.2119000119](https://doi.org/10.1073/pnas.2119000119).
- Goldstein EJC, Abrahamian FM (2015) **Diseases transmitted by cats.** *Microbiology Spectrum* 3(5). doi: [10.1128/microbiolspec.iol5-0013-2015](https://doi.org/10.1128/microbiolspec.iol5-0013-2015).
- Gompper ME (2014) **Free-ranging dogs and wildlife conservation.** Oxford University Press, Oxford, UK.
- Holland KE (2019) **Acquiring a pet dog: A review of factors affecting the decision-making of prospective dog owners.** *Animals* 9(4):124. doi: [10.3390/ani9040124](https://doi.org/10.3390/ani9040124).
- INEGI (2010) **Censo de población y vivienda. Principales resultados por AGEB y manzana urbana.** [<https://www.inegi.org.mx/app>] Accessed September 06 November 2024.
- Jacobson KC, Chang L (2018) **Associations between pet ownership and attitudes toward pets with youth socioemotional outcomes.** *Frontiers in Psychology* 9. doi: [10.3389/fpsyg.2018.02304](https://doi.org/10.3389/fpsyg.2018.02304).
- James G, Witten D, Hastie T, Tibshirani R (2017) **ISLR: Data for an Introduction to Statistical Learning with Applications in R.** [<https://cran.r-project.org/web/packages/ISLR/ISLR.pdf>]. Accessed September 06 November 2024.
- Kotzé JL, Grewar JD, Anderson A (2021) **Modelling the factors affecting the probability for local**

- rabies elimination by strategic control. *PLoS* 15(3):e0009270. doi: [10.1371/journal.pntd.0009270](https://doi.org/10.1371/journal.pntd.0009270).
- Lord LK (2008) **Attitudes toward and perceptions of free-roaming cats among individuals living in Ohio.** *Journal of the American Veterinary Medical Association* 232:1159–1167. doi: [10.2460/javma.232.8.1159](https://doi.org/10.2460/javma.232.8.1159).
- McCarthy RJ, Levine SH, Reed JM (2013) **Estimation of effectiveness of three methods of feral cat population control by use of a simulation model.** *Journal of the American Veterinary Medical Association* 15;243(4):502–511. doi: [10.2460/javma.243.4.502](https://doi.org/10.2460/javma.243.4.502).
- Mella-Méndez I, Flores-Peredo R, Amaya-Espinel JD, Bolívar-Cimé B, Mac Swiney GMC, Martínez AJ (2022) **Predation of wildlife by domestic cats in a Neotropical city: a multi-factor issue.** *Biological Invasions* 24:1539–1551. doi: [10.1007/s10530-022-02734-5](https://doi.org/10.1007/s10530-022-02734-5).
- Mella-Méndez I, Flores-Peredo R, Bolívar-Cimé B, Vázquez-Domínguez G (2019a) **Effect of free-ranging dogs and cats on medium-sized wild mammal assemblages in urban protected areas of a Mexican city.** *Wildlife Research* 46:669–678. doi: [10.1071/wr19074](https://doi.org/10.1071/wr19074).
- Mella-Méndez I, Flores-Peredo R, Pérez-Torres J, Hernández-González S, González-Urbe DU, Del Socorro Bolívar-Cimé B (2019b) **Activity patterns and temporal niche partitioning of dogs and medium-sized wild mammals in urban parks of Xalapa, Mexico.** *Urban Ecosystems* 22:1061–1070. doi: [10.1007/s11252-019-00878-2](https://doi.org/10.1007/s11252-019-00878-2).
- Morton R, Hebart ML, Whittaker AL (2018) **Increasing maximum penalties for animal welfare offences in South Australia—Has it caused penal change?** *Animals* 8:236. doi: [10.3390/ani8120236](https://doi.org/10.3390/ani8120236).
- Mota-Rojas D, Calderón-Maldonado N, Lezama-García K, Sepiurka L, De Cassia Maria Garcia R (2021) **Abandonment of dogs in Latin America: Strategies and ideas.** *Veterinary World* 2371–2379. doi: [10.14202/vetworld.2021.2371-2379](https://doi.org/10.14202/vetworld.2021.2371-2379).
- Ortega-Peñafiel SA, Cabrera MDM, Paz LGB, Goyes VEF (2021) **Infracciones, penas y multas por maltrato animal en América Latina.** *Socialium* 5(1):226–241. doi: [10.26490/unep.sl.2021.5.1.815](https://doi.org/10.26490/unep.sl.2021.5.1.815).
- Pereyra-Díaz D, Sesma J a. AP, Baizabal MÁN, Romero LG (2014) **Influencia de la niña y el niño sobre la canícula de la región de Xalapa, Veracruz, México.** *Ecosistemas y Recursos Agropecuarios* 16(32):71–79. doi: [10.19136/era.a16n32.563](https://doi.org/10.19136/era.a16n32.563).
- Peterson MN, Hartis B, Rodriguez S, Green M, Lepczyk CA (2012) **Opinions from the front lines of cat colony management conflict.** *PLoS ONE* 7(9):e44616. doi: [10.1371/journal.pone.0044616](https://doi.org/10.1371/journal.pone.0044616).
- Ripley B, Venables W, Ripley MB (2016) **Package ‘nnet’.** R package. [<https://cran.r-project.org/web/packages/nnet/nnet.pdf>]. Accessed 02 November 2024.
- Shuttlewood CZ, Greenwell PJ, Montrose VT (2016) **Pet ownership, attitude toward pets, and support for wildlife management strategies.** *Human Dimensions of Wildlife* 21(2):180–188. doi: [10.1080/10871209.2016.1116029](https://doi.org/10.1080/10871209.2016.1116029).
- Sinclair M, Lee NYP, Hötzel MJ, De Luna MCT, Sharma A, Idris M, Derkley T, Li C, Islam MA, Iyasere OS, Navarro G, Ahmed AA, Khruapradab C, Curry M, Burns GL, Marchant JN (2022) **International perceptions of animals and the importance of their welfare.** *Frontiers in Animal Science* 3. doi: [10.3389/fanim.2022.960379](https://doi.org/10.3389/fanim.2022.960379).
- Smith LM, Hartmann S, Munteanu AM, Villa PD, Quinnell RJ, Collins LM (2019) **The effectiveness of dog population management: A systematic review.** *Animals* 9(12):1020. doi: [10.3390/ani9121020](https://doi.org/10.3390/ani9121020).
- Smith LM, Quinnell R, Munteanu A, Hartmann S, Villa PD, Collins L (2022) **Attitudes towards free-roaming dogs and dog ownership practices in Bulgaria, Italy, and Ukraine.** *PLoS ONE* 17(3):e0252368. doi: [10.1371/journal.pone.0252368](https://doi.org/10.1371/journal.pone.0252368).
- Spotte S (2014) **Free-ranging cats: behavior, ecology, management.** Wiley Blackwell, New Jersey, USA.
- Sullivan P, Mijares S, Davis M, Oselinsky K, Cramer C, Román-Muñoz N, Stallones L, Edwards-Callaway L (2022) **A nationwide survey of animal science students’ perceptions of animal welfare across different animal categories at institutions in the United States.** *Animals* 12(17):2294. doi: [10.3390/ani12172294](https://doi.org/10.3390/ani12172294).
- Taylor LH, Wallace RM, Balaram D, Lindenmayer JM, Eckery DC, Mutoono-Watkiss B, Parravani E, Nel LH (2017) **The role of dog population management in rabies elimination—A review of current approaches and future opportunities.** *Frontiers In Veterinary Science* 4. doi: [10.3389/fvets.2017.00109](https://doi.org/10.3389/fvets.2017.00109).
- Toukhsati SR, Bennett PC, Coleman GJ (2007) **Behaviors and attitudes towards semi-owned cats.** *Anthrozoös* 20(2):131–142. doi: [10.2752/175303707x207927](https://doi.org/10.2752/175303707x207927).
- Toukhsati S, Phillips C, Podberscek A, Coleman G (2012) **Semi-Ownership and sterilisation of cats**

and dogs in Thailand. *Animals* 2(4):611–627. doi: [10.3390/ani2040611](https://doi.org/10.3390/ani2040611).

Van Heezik Y, Smyth A, Adams A, Gordon J (2009) **Do domestic cats impose an unsustainable harvest on urban bird populations?** *Biological Conservation* 143(1):121–130. doi: [10.1016/j.biocon.2009.09.013](https://doi.org/10.1016/j.biocon.2009.09.013).

Vanak AT, Gompper ME (2010) **Interference competition at the landscape level: the effect of free-ranging dogs on a native mesocarnivore.** *Journal of Applied Ecology* 47(6):1225–1232. doi: [10.1111/j.1365-2664.2010.01870.x](https://doi.org/10.1111/j.1365-2664.2010.01870.x).

Weston MA, Fitzsimons JA, Wescott G, Miller KK, Ekanayake KB, Schneider T (2014) **Bark in the park: A review of domestic dogs in parks.** *Environmental Management* 54(3):373–382. doi: [10.1007/s00267-014-0311-1](https://doi.org/10.1007/s00267-014-0311-1).

Zar JH (1999) **Biostatistical analysis, 4th edition.** Prentice-Hall, New Jersey, USA.

Zito S, Vankan D, Bennett P, Paterson M, Phillips CJC (2015) **Cat ownership perception and care-taking explored in an internet survey of people associated with cats.** *PLoS ONE* 10(7):e0133293. doi: [10.1371/journal.pone.0133293](https://doi.org/10.1371/journal.pone.0133293).

Received: 13 November 2024

Accepted: 14 August 2025

Published: 12 January 2026

Editor: Rômulo Alves



Additional Files

Add File 1: Survey used

SECTION A (demographic variables)

Socio-economic status (Low, Middle, High) Ownership type (Owner, Semi-owner) Sex (Male, Female) University education (With, Without)

SECTION B (Likert scale)

1. Dogs and cats should use urban green areas as shelter sites (Strongly disagree/disagree/neutral/agree/Strongly agree).

2. Dogs and cats should use urban green areas as breeding sites (Strongly disagree/disagree/neutral/agree/Strongly agree).

SECTION C (binomial scale)

1. Do you agree that dogs and cats should prey on wildlife in urban green areas?

Yes No

2. Do you agree that dogs and cats should defecate on public roads and in urban green areas?

Yes No

3. Do you agree that dogs and cats should roam freely in the streets?

Yes No

4. Do you agree that pet owners should pay fines for irresponsible pet ownership?

Yes No

5. Do you agree that sterilization campaigns for dogs and cats should be encouraged?

Yes No