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Traumatic injuries in common birds caused by dogs & cats in urban and peri-urban zones from Northern Andes

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Ariel Fernando Guerrero Campoverde

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Ariel Fernando Guerrero Campoverde

Nombre del profesor, Título académico **Diego F. Cisneros-Heredia PhD**

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Código: 00213063

Cédula de identidad: 1750000950

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RESUMEN

Los perros y gatos han sido una de las amenazas latentes dentro de los ataques a diferentes grupos de aves, donde los datos de depredación hacia avifauna en todo el mundo son alarmantes. Además, para los Andes norte se carece en su mayoría de información precisa sobre los efectos traumatológicos de ataques de perros y gatos en avifauna. Por ello, conocer las lesiones traumáticas causadas por perros y gatos, es necesario para entender los tipos de fracturas que causan y su estado de salud, para así plantear estrategias para mitigar este problema. Este estudio evaluó las lesiones traumáticas (fracturas) causadas por ataques de perros y gatos en aves de la ciudad que fueron atendidas en el Hospital de Fauna Silvestre TUERI. Los resultados revelaron una tendencia de ataques en extremidades posteriores y anteriores. Además, la evaluación del Índice de Condición Corporal (ICC) indicó que los ataques fueron a individuos con un ICC entre 3 y 2.5, lo que sugiere que las aves atacadas se encontraban en buen estado de salud. Uno de los sesgos importantes fue la presencia de reportes en lugares con mayor poder socioeconómico, el cual resalta la importancia de equidad social, económica y ambiental para el mejorar problemas.

Palabras clave: Avifauna, Ciudades, Fracturas, Mascotas, Urbanización

ABSTRACT

Dogs and cats have been one of the latent threats within the attacks to different groups of birds, where the data of predation to avifauna worldwide are alarming. In addition, for the northern Andes, there is a lack of accurate information about the traumatological effects of dog and cat attacks on avifauna. Therefore, knowing the traumatic injuries caused by dogs and cats is necessary to understand the types of fractures they cause and their health status to propose strategies to mitigate this problem. This study evaluated traumatic injuries (fractures) caused by dog and cat attacks on birds in the city treated at the TUERI Wildlife Hospital. The results revealed a trend of attacks on hind and forelimbs. In addition, the Body Condition Index (BCI) assessment indicated that the attacks were on individuals with a BCI between 3 and 2.5, suggesting that the attacked birds were in good health. One of the important biases was the presence of reports in places with higher socioeconomic power, which highlights the importance of social, economic, and environmental equity in improving problems.

Key words: Avifauna, Cities, Pets, Responsibility, Urbanization

TABLA DE CONTENIDO

ÍNDICE DE FIGURAS

INTRODUCTION

Urbanization has been increasing in recent years across the world, leading to an environmental transformation that is particularly affecting green areas and has a significance in our culture, sociology, behavior, and politics (Marzluff, 2008). In recent years, urbanization has leading negative impacts on fauna (Smart & Smart, 2003; Tietze, 2018), highlighting problems such as noise contamination, chemical contamination, light pollution, invasive species, pathogens, and fragmentation (Blair & Johnson, 2008; Shochat et al., 2010; Hughes & Macdonald, 2013; Hernández-Brito et al., 2014; Shochat et al., 2015; Doherty et al., 2015, 2016, 2017; Yao et al., 2022; Winchell et al., 2023). However, urban dynamics and growth are directly associated with avifauna threats such as decreasing bird abundance, diversity, and avian health and welfare issues (Biamonte et al., 2011; Burton & Doblar, 2004; Panter et al., 2022). The most outstanding health concerns in bird populations are traumatic injuries (fractures, dislocations, fissures, cracks), metabolic diseases (hypertension, diabetes, stress), and parasitic diseases (toxoplasmosis, leishmaniasis, trichomoniasis) (Stenkat et al., 2013; Cabrera Hanna, 2017; Díaz et al., 2023). However, traumatic injuries are different from the other concerns due to their origin being both natural and anthropocentric.

Cities expose birds' health to different environmental stressors. The susceptibility of birds' welfare is compromised by cities' environmental stressors and traumatic injuries, compromising the survival rate for urban fauna (Blickley et al., 2012; Biard et al., 2017; Shochat et al., 2015). In the case of birds, these environmental stressors are direct impacts caused by cities, such as collisions with urban structures such as houses, vehicles, windows, and buildings; or indirect causes related to people, such as people's perceptions, driving by shooting or captivity; and non-native species, mainly driving by dogs and cats (Palomino & Carrascal, 2007; Cousins et al., 2012; González-Astudillo et

al., 2016; MacDonald et al., 2016; Montesdeoca et al., 2017). Those fractures provoke critical hazards to avifauna health; traumatic fractures in avifauna are among the most important hazards to animals' welfare.

Dogs and cats pose a significant threat to biodiversity and native species; contributing to biodiversity loss, interspecific competition, habitat displacement, and increasing mortality (Banks & Bryant, 2007; Medina et al., 2011; Young et al., 2011). Moreover, domestic predators continuously disturb avian communities through the transmission of pathogens, rabies, or traumatological problems (Hughes & Macdonald, 2013; Loss et al., 2013). Also, they represent a major threat due to their opportunistic hunting behavior, which leads to traumas (Smith et al., 2000). Traumatic injuries compromise bird health regardless of their source. Although domestic predators are usually viewed as efficient and successful hunters, however, they are also implicated in causing traumatic injuries (Young et al., 2011; Rodríguez et al., 2020; Andrzejczak et al., 2021; Carrasco-Román et al., 2021).

Domestic predators are classified based on range attack behaviors, usually defined into three categories based on their range and movement: free-roaming, feral, and stray. Free roaming generally does not move far away from their home, while stray pets lack a permanent resident but often return for sleep and eat, and feral dogs are independent of human support (Barnett, 1986). This classification of domestic predators indicates their high capacity to cause negative effects on fauna; for example, feral and stray dogs tend to make proper attacks related to the mortality of wildlife, leading to traumatological injuries, while domestic dogs are related to hybridization (in mammals), attacks on humans, and disease transmission (Cornelissen & Hopster, 2010; Young et al., 2011; González-Astudillo et al., 2016; Montesdeoca et al., 2017). Cats are usually associated

with generalist behavior, and their incidence of predation is regardless of the behavior and their range of movement (Nogales et al., 2004).

Recent reports documented about cat and dog predation on wildlife have been reported worldwide. Countries such as Australia, Canada, the United States, the United Kingdom, and Cape Town in South Africa recorded alarming predation rates per year caused by domestic predators, highlighting mortality problems, animal welfare, and health problems (Loss et al., 2013; Woinarski et al., 2017; Seymour et al., 2020). Nevertheless, information from Northern Andes countries is missing. The only available data is in Colombia, with an estimated 8 to 29 million dead birds per year caused only by cats, indicating a significant concern (Sedano-Cruz, 2022). This data highlights the high mortality issues related to dog and cat attacks. Moreover, compared with other urban morbidity factors such as building collisions, high-tension lines, pesticides, cars, and trains, predation by dogs and cats significantly surpasses the mortality rate (Loss et al., 2013; Doherty et al., 2015; Loss & Marra, 2017). Moreover, previous information from USFQ-Wildlife Veterinary Hospitals in Quito indicates that dog and cat attacks are the primary cause of fauna admissions in Quito, highlighting the same pattern in Ecuador (Díaz et al., 2023).

Unfortunately, the adverse effects of dogs and cats are not limited to wildlife; human health problems, such as the transmission of diseases or severe cases of dog attacks on people, make their presence a public health problem (Overgaauw et al., 2020; Barrios et al., 2021). This type of public health problem requires governmental attention and public policies based on the scientific information available in order to mitigate the negative impacts on human and wildlife populations (Cornelissen & Hopster, 2010; Garde et al., 2013; Dias et al., 2015; Garde et al., 2022). Usually, public policies are focused on adoption, and sterilization for common strategies to manage, control, and

mitigate the dog population and their welfare issues (Jackman & Rowan, 2007; Barnard et al., 2015; Smith et al., 2019).

This study aims to evaluate the traumatic injuries caused by dogs and cats in the most common avifauna in Quito, the morbidity and mortality, health status, and social panorama of bird arrivals based on the data collected by the Wildlife Veterinarian Hospital of the Universidad San Francisco de Quito and socioeconomic data between 2020 and 2022. This work seeks to understand the dynamics of traumatological data and social panorama for health care and conservation of avifauna in Quito.

METHODOLOGY

STUDY AREA

Quito, the capital city of Ecuador, is located in the Northern Andes, with an area of 4,183 km2 divided into 65 parishes and more than 2'200.000 inhabitants in the city. The urban area of que DMQ is located between the massif of Pichincha volcano and the inter-Andean valleys of "Valle de los Chillos" and "Tumbaco" (Cuvi, 2022). Urban and rural parishes were considered according to their location and population density previously established by "Municipio de Quito" (Figure *1*). The estimated density of free-roaming dogs in urban and rural parishes in Quito is 8.33 dogs/km and 6.51 dogs/km, respectively, representing more than two-fold growth in only the last year (Cárdenas et al., 2021). There are no records for the cat survey population in Quito.

STUDY SPECIES

The selected species in Quito were *Zenaida auriculata*, *Turdus fuscater,* and *Zonotrichia capensis* by previous surveys in the city and by their high abundance (Cisneros-Heredia et al., 2015), and *Porphytio martinica* was selected by the high number of individuals arriving in TUERI (Díaz et al., 2023).

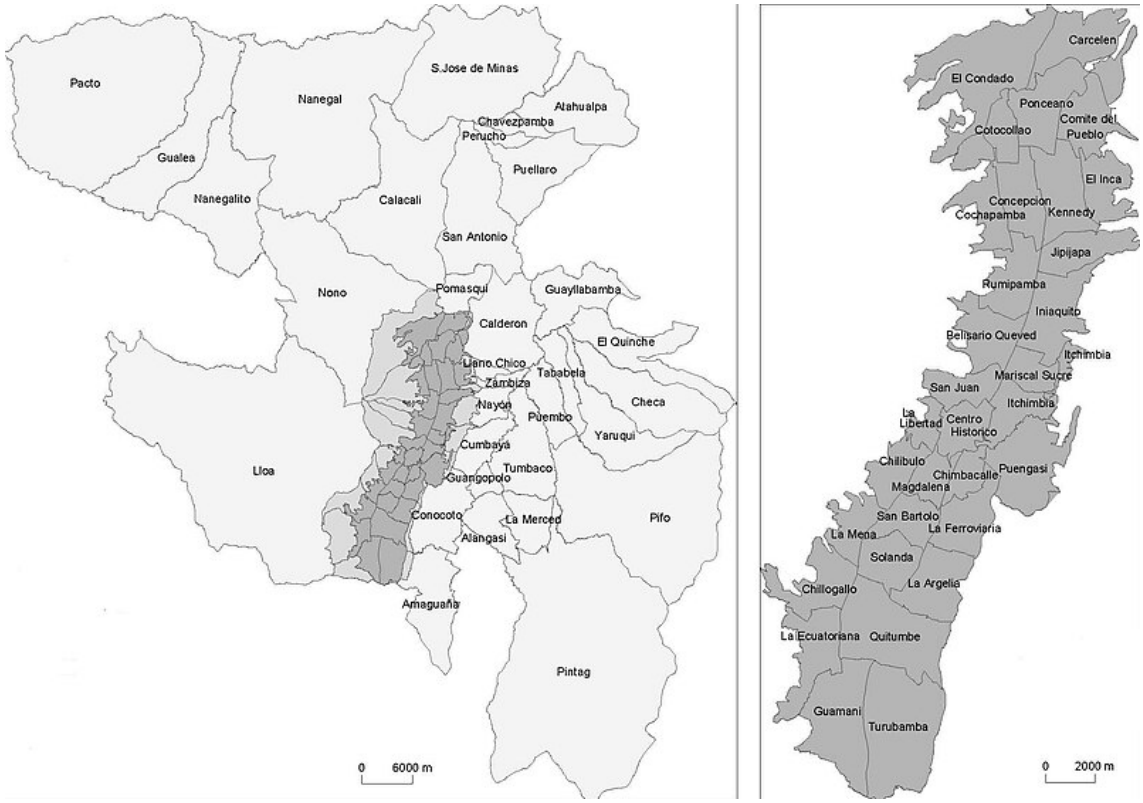

Figure 1: Map of Quito divided into urban and peri-urban zones.

Description. The darkest gray corresponds to urban areas and white to peri-urban areas. Source: (Hflopez2000, 2009)

DATA COLLECTION

This study was conducted over three years, from January 2020 to December 2022. The USFQ-Wildlife Veterinary Hospital TUERI provided a general database, which was

then populated using hospital medical records data. This information was compiled by reviewing each record of every bird species admitted to TUERI, where information was extracted on the birds' physical, physiological, and anatomical examinations, indicating their health conditions. In addition, information from the entry forms was added with relevant information such as the history of events adjacent to the individual found, the state it was in, and where it was found.

The clinical form takes data such as temperament (Docile or Aggressive), weight (Grams), temperature (Celsius), heart rate (Beats per minute), respiratory rate (breaths per minute), mucous membrane (Color), distal capillary refill time (Seconds), percentage dehydration (%) and body condition index (BCI). BCI is a numeric score based on muscle and fat coverage along the sternum zone. Veterinarians use it to determine the bird's health status with a scale between 0 and 5, meaning zero malnutrition and five obesities. Healthy individuals have scores above 2.5, and unhealthy individuals have scores below 2.5 (Donoley, 2016). Besides, all the individuals were classified by date of admission, cause of admission, origin of the patient, sex, age, and outcomes (euthanized, released, died, transferred).

Identifying dog and cat attack cases was confirmed in two ways: the storytelling by the person who brought the species and the wound pattern. The wound pattern varies between dogs and cats, which for dogs is described as a wide bite due to their wider jaws; in contrast, cats have a narrow and weaker bite than dogs (Smith et al., 2000). We consider the main bone trauma (fractures), excluding others such as dislocation and luxation, and exclude other traumas at the muscular or dermal level. Traumatic injuries were categorized according to the bird bone anatomy (Cummings et al., 2022), and divided into four main zones: head, core, fore limb, and hind limb. Every report was considered unique, even if the individual presented multiple bone fractures.

DATA ANALYSIS

We analyze the frequency of bone fractures based on their attack zone and which domestic predators caused bird arrivals to TUERI. Statistical analysis was conducted using RStudio 4.3.1, with a ggplot2 package for figures. To analyze differences between species' bone fractures and dog and cat bone fractures, the Chi-squared goodness of fit test was used to determine differences between bone cracks, bird attack preference, and dog and cat attacks. We evaluated the Body Condition Score (BCI) for bird health status.

We use ArcGIS pro-3.2.1 for maps. Shapefiles of "Densidad Poblacional," "Clasificacion Agrologica del Suelo," and "Areas de Valoración por Metro Cuadrado" were extracted in Geoportal Metropolitano, created by Municipio de Quito and "Secretaria General de Planificación." We overlap all the information with the historical records from TUERI (Municipio de Quito & Secretaria de Planificación, 2023).

RESULTS

A total of 862 individuals of common bird species were admitted to TUERI between 2020 and 2022, of which 164 individuals were admitted by dog and cat attacks. The most abundant species was *Zenaida auriculata* with 84, *Turdus fuscater* with 33, *Zonotrichia capensis* with 30, and *Porphyrio martinica* with 17 (Figure *2*). Of these, 61 individuals were euthanized (37.2%), 64 died (39%), 32 were released (19.5%), and seven were transferred to a wildlife center (4.3%) (Figure *2*). These results reflect significant differences in the fate of the birds, with dogs and cats usually being the most common cause of death or euthanasia (X-squared = 52.829, df = 3, p-value = 1.994e-11).

Figure 2: Total frequency of individuals arriving at TUERI, divided by recovery and death.

Cats were responsible for 81 attacks, dogs for 80, and three were mixed dog and cat attacks. Cat attacks resulted in the death of 67 individuals (83%) and dogs in 55 (69%). Notably, cat attacks have a higher fatality rate than dog attacks. Regarding bone fractures, the fractures are 18 Tibiotarsus, 16 Radius/ulna, 13 Femur, nine Humerus, seven Carpometacarpus; two in Hip, Coracoid, Beak, and unspecific forelimb fractures; one in Clavicle, Scapulae, Phalange, and Undetermined site. With significant difference in bone fracture preference site (X-squared = 80.27, df = 12, p-value = 2.87e-12). Furthermore, the distribution based on zones shows two for the head, six for the core, 33 in the Hind limbs, and 34 in the Forelimbs (Figure *3*). 59/164 individuals present at least one consolidated fracture; 46/59 had one bone break, 10/59 had a double bone

break, 2/59 had a triple bone break, and 1/59 had quadruple bone break, totaling 75 bone cracks. Examination of attack patterns across different zones indicated a similar distribution between dogs and cats concerning injuries to the forelimbs, head, and core areas. However, dogs displayed a tendency to target the forelimbs more frequently. Besides, *Zenaida auriculata* present higher numbers of bone fractures in zones (Figure *4*).

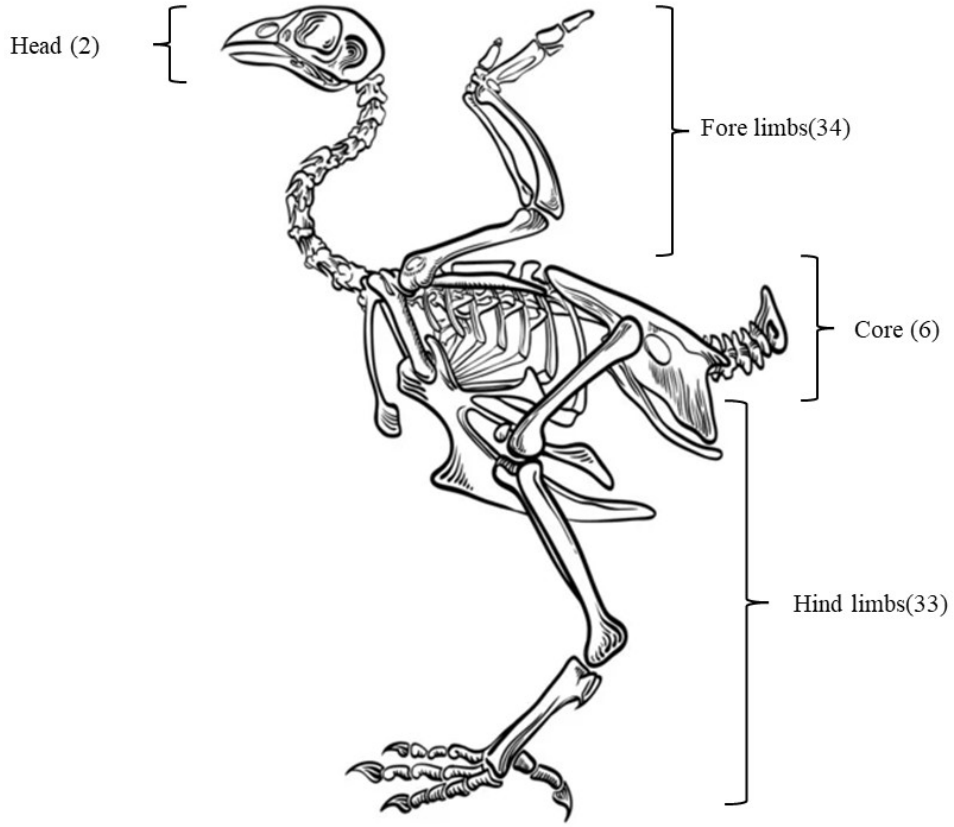

Figure 3: Bone scheme for all the individuals admitted in TUERI.

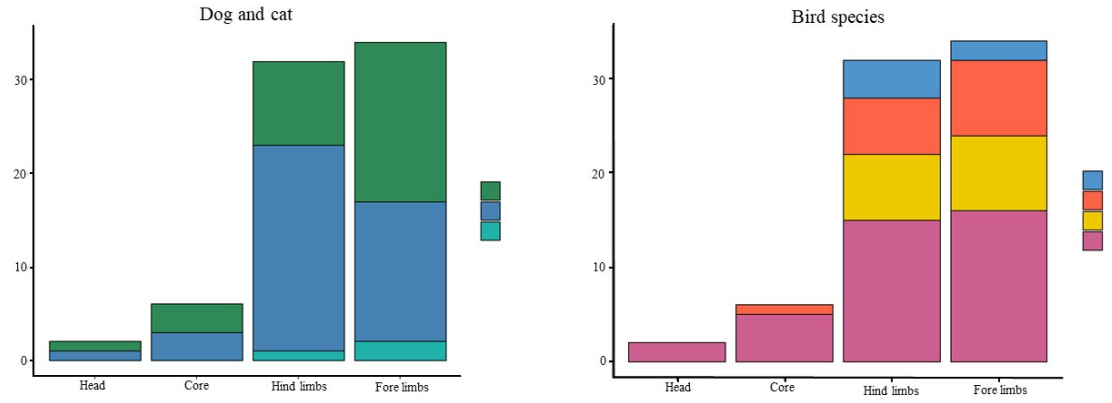

Figure 4: The frequency of zone attacks is distributed by dogs and cats, and the frequency of attacks by area is distributed by species suffering fractures.

Description: The graph on the left shows the frequency of zone fractures divided into perpetrators, green for cats, blue for dogs, and light blue for dogs and cats. On the right frequency of bone zone fractures with bird species, *P. martinica* is light blue, *Z. capensis* is orange, *T. fuscater is* yellow, and *Z. auriculata* is pink.

Of the 164 individuals affected by dog and cat attacks, 13 were not evaluated for Body Condition Index (BCI). Among the evaluated species, *P. martinica* had 12 individuals with BCI scores above 2.5 and four below, *T. fuscater* had 23 above 2.5 and six below, *Z. auriculata* had 62 above 2.5 and 16 below, and *Z. capensis* had 24 above 2.5 and five below 2.5. However, the pattern was almost conserved when examining BCI scores for dead individuals; only *P. martinica* presents a reduction in healthy individuals. For *P. martinica*, five individuals had BCI scores above 2.5 and two below. For *T. fuscater*, 15 were above and five below; for *Z. auriculata*, 44 were above 2.5 and 16 were below 2.5; and for *Z. capensis*, 23 were above 2.5 and four below 2.5. Notably, the BCI for deceased *P. martinica* individuals showed a decrease in healthy individuals, reducing individuals in healthy condition and keeping unhealthy individuals (Figure 5).

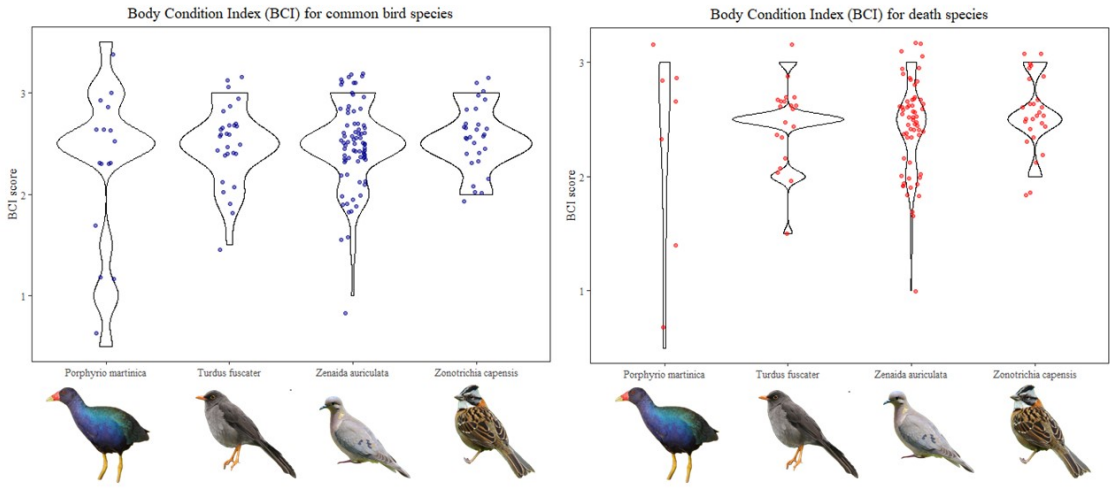

Figure 5: Violin plot for BCI for all the bird species, and all the death species admitted in TUERI.

In the maps, the highest common bird concentrations arrived in TUERI and came from Cumbaya (37), Tumbaco (25), and Iñaquito (18). Besides, the analysis shows that income indicates that more individuals come from sites with higher purchasing power (Figure *6*). Moreover, it is a trend in areas with medium population density, which shows higher individual arrival (Figure *7*). Finally, most birds' arrivals come from urban landscapes (Figure *8*).

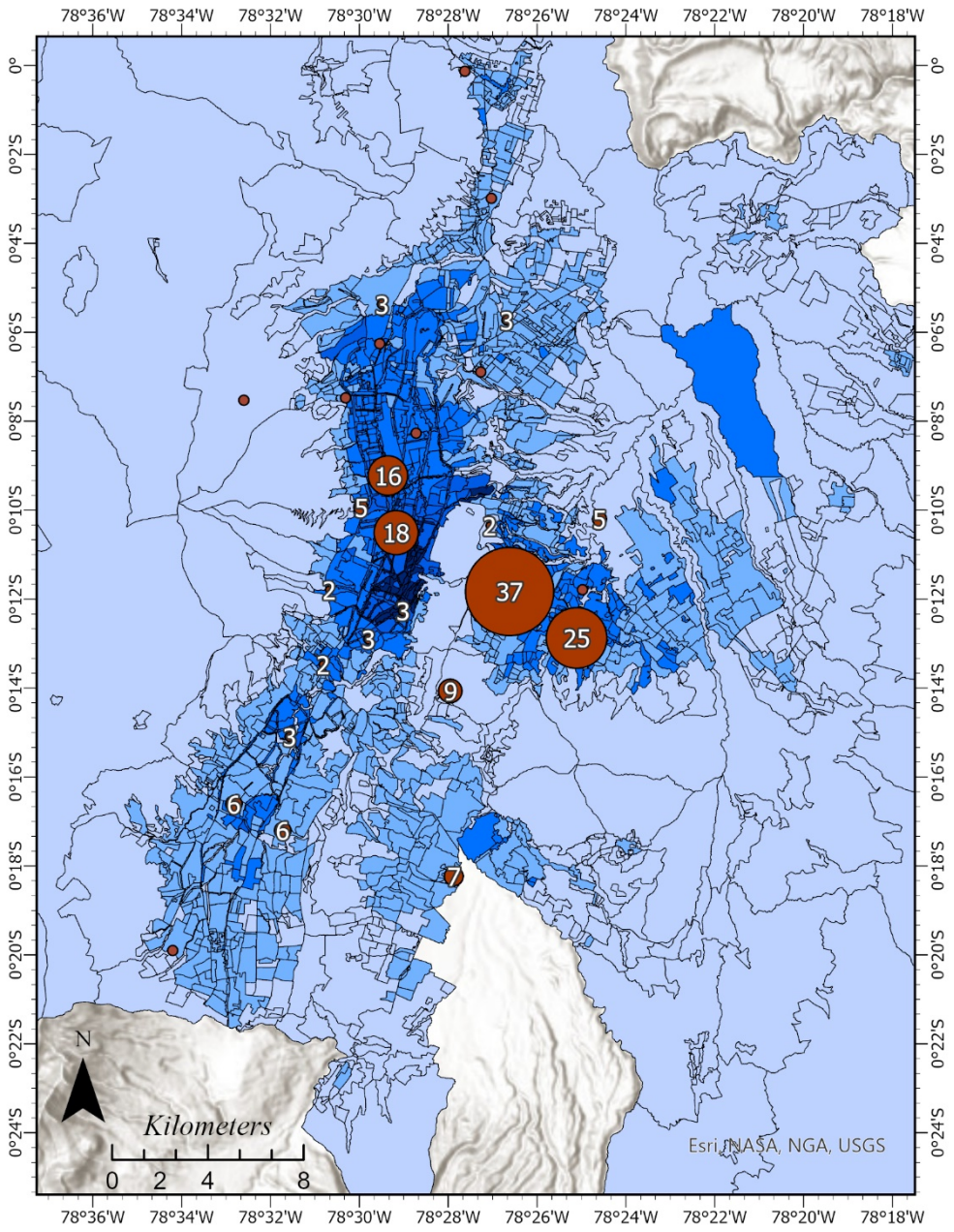

Figure 6: Map of Quito's square meter value and bird record arrivals at TUERI.

Description: The places with the highest value per square meter presented a darker blue, while the light blue represented areas with the lowest value per square meter.

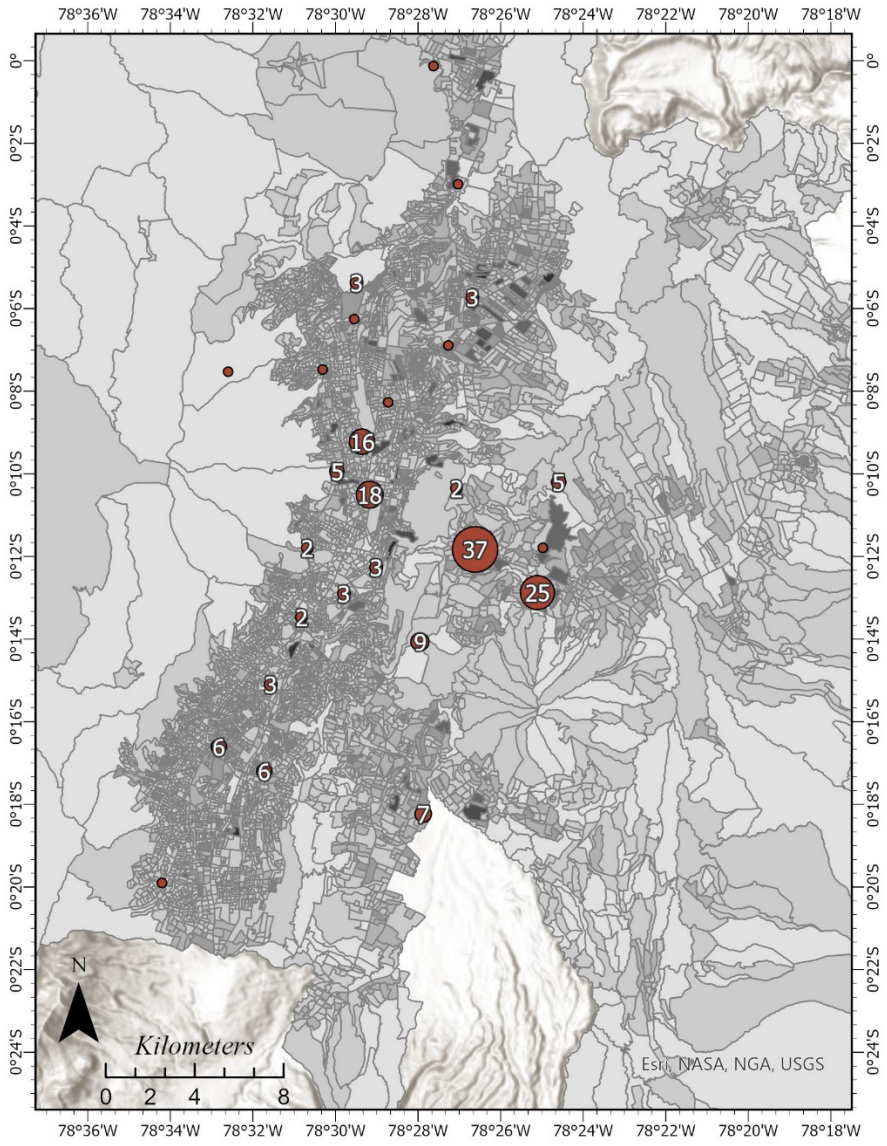

Figure 7: Map of Quito's population density and bird record arrivals at TUERI.

Description: The darkest gray area in Quito has the highest population density, and the lightest gray areas are the least populated.

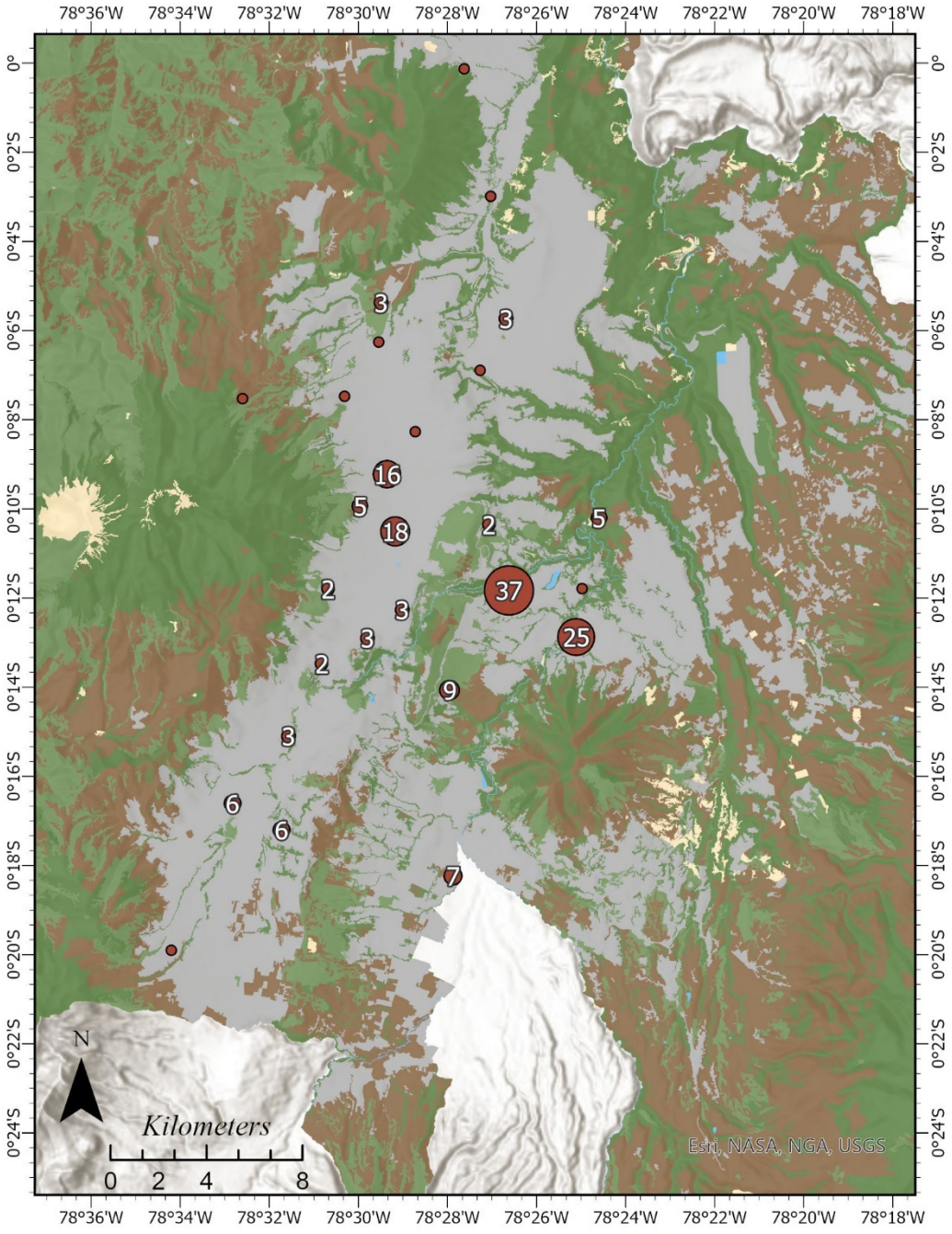

Figure 8: Map of Quito's land use and bird record arrivals at TUERI.

Description: Water is light blue, green is forest, brown is agricultural lands, and gray is urban areas.

DISCUSSION

Our data suggests that dog and cat attacks pose a significant threat to the avifauna's health status, often causing death or euthanasia for most individuals arriving in TUERI. Moreover, dog and cat attacks cause traumatic injuries in almost all body parts, with a tendency to attack the forelimbs and hind limbs. The attacks present a similar distribution for dog and cat attacks in the head, core, and forelimbs. However, dogs tend to attack hind limb zones more often than cats. The health status of bird arrivals in TUERI suggests that dogs and cats attack, kill, and provoke euthanasia in healthy and unhealthy individuals, showing a widespread pattern of attacks.

VETERINARIAN AND ECOLOGICAL IMPLICATIONS

Dog and cat predation is a severe problem in Quito, reflecting the same situations as in other cities. Our results suggest that traumatic injuries (bone fractures) put in risk even more avian health (Doherty et al., 2017; Loyd et al., 2017; Woinarski et al., 2017; Sedano-Cruz, 2022; Díaz et al., 2023). Dog and cat attacks on birds are only the scoop for all the environmental hazards that birds face in cities related to human activities (building and road collision, poisoning, habitat reduction, and even other invasive species) (Chace & Walsh, 2006). Nevertheless, dog and cat attacks should not be underestimated as a problem because it was previously reported as one cause of bird population declines (Loss et al., 2013; Doherty et al., 2016). These direct anthropocentric effects reflect cities (and Quito) as challenging environments for birds. (Biard et al., 2017; Tryjanowski et al., 2020). They show the necessity of improving cities' resilience and sustainability to create an affordable bird environment. (MacGregor-Fors & Schondube, 2011; Chiquet et al., 2013).

Trauma often leads to bird's arrival at wildlife hospitals (Stenkat et al., 2013; González-Astudillo et al., 2016; Loyd et al., 2017; Mcruer et al., 2017; Cummings et al., 2022). In instances of traumatological problems, attacks by dogs and cats predominantly target the hind and forelimbs of the common bird species. However, the lack of information on traumatic injuries, bone fractures, and the causes and attacks of dogs makes it impossible to compare them with other birds' taxonomic groups. One example is koalas, which shows that dogs and cats prefer to attack their rib and torso and cause fractures, contrasting with our data on hindlimb and forelimb preference (Henning et al., 2015). According to this information, dogs and cats have no zone attack preference for all the taxa; those can vary according to the prey, making them successful predators in almost all environments and with almost every prey.

One critical aspect analyzed was the Body Condition Score, a valuable method for quantifying the average condition of birds and providing important information about individuals' health conditions (Donoley, 2016). Previous information suggests that pet attacks target individuals with lower body mass, who, despite the attack, will die because of some other factor. (Baker et al., 2008). Nevertheless, our results contrast the previous information about dog and cat attacks; for *Zenaida auriculata, Zonotrichia capensis*, and *Turdus fuscater*, a higher percentage of birds in good muscle and fat condition were attacked and killed in DMQ. In contrast, *Porphyrio martinica* does not seem to follow the same pattern, with a decrease in individuals with good health killed with a good BCI. Rallidae species (*P. martinica* family) exhibit increased vigilance behavior in areas where dogs are present because barking alerts them (Randler, 2006). This previous information suggests that Rallidae members become more vigilant, reducing other crucial behaviors necessary for their survival, such as foraging, nesting, and reproduction (Randler, 2006; Loss & Marra, 2017). This information about dogs

and cats attacking birds in healthy and unhealthy status is related to the reports of the high number of species hunted and the bird population declines (Medina et al., 2011; Hughes & Macdonald, 2013; Doherty et al., 2017; Woinarski et al., 2017; Bonacic et al., 2019; Garcês et al., 2019; Cummings et al., 2022). In addition, knowledge of traumatic attacks can be vital in working to recover attacked individuals and improve institutional response systems that work to mitigate domestic predator-wildlife conflict.

The removal of dogs and cats from native ecosystems is one of the most discussed and accepted issues because of their significant negative impacts previously studied in native environments (Soulé et al., 1988; Woudt, 1990; Hughes & Macdonald, 2013; Rivas et al., 2014; Zapata-Ríos & Branch, 2016; Lawson et al., 2018). However, an essential factor to consider is the role of introduced mammals in the food webs of urban landscapes. Previous information suggests that dogs and cats in cities have a role in controlling other non-native species, which act as "mesopredators" and may cause an equally complex effect known as "mesopredator release," in which mesopredators will have a more significant impact on wildlife than other predators above them (Courchamp et al., 1999). This should be evaluated in cities due to different ecosystem impacts and complexity, such as age, density, size, geography, and other variables that make each city unique (Johnson & Munshi-South, 2017; McDonnell & Hahs, 2015). In this context, studies are required on the specific avifauna impacts of Quito to have practical measurements for mitigation and quantifying the impacts of dogs at home, which are scarce and must have a different threat pattern (Perkins et al., 2021).

CONSERVATION IMPLICATIONS

Providing a conservation framework without considering people's perceptions and support is impossible and unsuccessful, especially in ecosystems dominated by people

(Sinemillioglu et al., 2010; Hughes & Macdonald, 2013; Sakurai et al., 2015; Shwartz et al., 2014; Aguado et al., 2018). Reports of attacks come from widespread localities in the DMQ, with a clear preference for inhabited urban areas of Quito and medium population densities. This indicates a close relationship between humans, pets, and pet attacks. The people's socioeconomic status was calculated using the value per square meter of the city, effectively showing how medium, medium-high, and high socioeconomic status showed a greater number of records in these areas.

Socioeconomic inequality is usually not considered a significant factor in conservation studies; however, in recent years, it has been taken into consideration for resilience in urban ecosystems and as a way to understand social and ecological problems(Silva-Ortega et al., 2023; Villaseñor et al., 2024). An example of ecological inequality is dog and cat abundance. Usually, low incomes are accompanied by a lack of space and poor financial solvency, which results in a greater likelihood of establishing feral and invasive populations due to increased abandoned pets and adverse effects on the ecosystem (Bonacic et al., 2019; Muñoz-Pacheco & Villaseñor, 2023). This is a key factor for solving critical problems of dog and cat abandonment, dog and cat attacks, and management directions. However, our results suggest higher reports on medium to high socioeconomic status zones. These results consider multiple variables that are affecting the cities, diversity complexity, and diversity, such as inequality in education, access to gardens and parks, and access to information, which might be factors leading to the inequality data distribution (Pickett, 2001; Cohen et al., 2012; Manfredo et al., 2020). While reflecting the amount of data should not approach the number of attacks and deaths caused for dogs and cats, these data reflect the problems associated with attacks on avifauna health, animal welfare, and ecological and social inequity in Quito.

Conservation is usually attached and achieved to governmental policies, following society's problems and providing straightforward measurements for reducing environmental hazards (Rands et al., 2010; Paloniemi et al., 2012). The legal framework for reducing dogs' and cats in stress should focus on pet protection, adoption, and sterilization, ensuring coexistence between pets and humans (Dias et al., 2015). Nevertheless, the negative consequences on feral animals and native species may persist, requiring drastic measures to face severe problems. Moreover, prioritizing the health of the environment and people through euthanasia is a desperate but necessary policy to consider for reducing feral populations, and the government has the responsibility to achieve ecosystem resilience and solve public health problems (Hernández Bustos & Fuentes Terán, 2018).

CONCLUSION

Dogs and cats directly compromise birds' health, and their attacks tend to have traumatological consequences that are difficult to treat and mitigate. These individuals have such a high attack capacity that they even attack healthy individuals, which reflects why they have caused population declines and local extinctions elsewhere. Both public policy and personal management are required to ensure that this problem is reduced. In addition, studying the consequences of dogs and cats will continue to generate valuable information that will lead to improved veterinary studies and decision-making.

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