Health and Ecological Aspects of Stray Cats in Old San Juan, Puerto Rico: Baseline Information to Develop an Effective Control Program

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The overpopulation of stray cats in urban areas represents a potential risk for humans, as stray cats may carry diseases, such as toxoplasmosis, and virus such as rabies, the feline immunodeficiency, and the feline leukemia. In Old San Juan, a historic neighborhood and one of the most touristic places in Puerto Rico, there is an overpopulation of stray cats. In this study, we generated baseline information fundamental to developing a successful control program by estimating the stray cat population size, density, and spatial distribution. Furthermore, we quantified the number of neutered cats and developed a spatial database to include information about the external physical condition of each individual. We estimated a population of 178 (±21) cats, with a density of 3.6 cats/ha. Overall, we observed 209 cats, from which 149 (71%) were identified as new and 60 (29%) were recaptured. We found stray cats had a significant non-random and clustered spatial distribution (z-score = -19.39 SD; ratio = 0.29; p<0.0001), with an observable larger abundance in residential zones where food was provided. A total of 105 (70%) cats were neutered, and 32 (21%) individuals exhibited very poor physical conditions, including skin problems, scars, underweight, and blindness. We concluded that the ecological and descriptive data generated in this study are essential for an effective control of stray cats and their potential impacts on humans living in this neighborhood. [*P R Health Sci J 2018;37:110-114*]

Key words: Felis catus, Feral cats, TNR program, Population control, Urban cats

The domestic cat (*Felis catus*) is one of the first domesticated species and most popular pet in the world (1), with a total population estimated to be approximately 400 million (2, 3). A global problem of free-ranging cats in urban areas has required controlling their populations, as stray cats pose a potential risk for human health and safety. Stray cats may carry diseases, such as rabies and toxoplasmosis, and such viruses as the feline immunodeficiency virus and the feline leukemia virus (4, 5). These infectious diseases can be transmitted to humans, indoor pets, and wildlife, causing serious medical conditions, including miscarriage, blindness, and even death (6, 7, 8, 9). In addition to this, stray cats are carnivores and skilled predators, representing one of the most important causes of mortality for birds and mammals in many countries (10, 11, 12, 13, 14) and being a major contributor of species extinction on many islands where they have been introduced (15, 16).

Traditional management programs to control, reduce, and eventually remove colonies of stray cats from urban areas include trap and relocation to shelters for later adoption and euthanasia (17). Another widely implemented program is trap, neuter, and return (TNR), which consists of trapping cats, surgically sterilizing (or neutering) them, and returning them to the streets (17, 18). Despite the fact that TNR in combination with a successful adoption program reduced some colonies of stray cats in various urban areas of United States (19, 20), this method was ineffective in many other circumstances (21). First, TNR was ineffective when populations were open (where migration and emigration occur) or contained more than 50 individuals (21). Second, positive effects on reducing the size of a given population were observed after several generations, post-implementation, but when TNR was discontinued, the population in question rapidly increased (15, 22). Third, TNR was ineffective in addressing other impacts associated with large populations of stray cats, including predation, diseases, and odors from the cats' urine and feces in public areas (23, 24, 25, 26, 27). In this regard, TNR is not supported by the scientific community, as it is not a tangible solution for the different issues related to colonies of stray cats in urban areas (28, 15, 17).

In Old San Juan, an urban neighborhood that is one of the most popular touristic destination in Puerto Rico, there is a

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problem of stray-cat overpopulation. Stray cats have been an issue of public debate in this neighborhood for a while. By the year 2000, the United States National Park Services and other federal agencies proposed a plan to control stray cats that was rejected by the local community, as it included euthanasia (29). Since then, both a local non-governmental organization called Save a Gato (SaG) and a cat shelter were established to advocate for the welfare of the cats under discussion; and started implementing TNR as a strategy to reduce and control the population of stray cats in Old San Juan. As a means of controlling the stray-cat population in this neighborhood, a program that combined TNR and adoption was implemented 10 years ago, but it remains unknown how effective that program has been. Furthermore, it is unclear if stray cats represent an important health issue for residents and visitors that would require action from governmental agencies.

In this study, we estimated the size and spatial distribution of the population of stray cats inhabiting Old San Juan, fundamental baseline information needed to assess population trends, TNR effectiveness, and the potential health impacts on humans. Furthermore, we quantified the number of neutered cats, and developed a spatial database that includes information about the external physical condition of each animal to facilitate later identification, tracking, and monitoring.

Materials and Methods

Study area

Old San Juan is a historic Spanish colonial urban area in San Juan, Puerto Rico's capital city; it is located on the northeast coast of the island (Fig. 1). This area has a year-round human population of approximately 100,000, but receives more than 1 million tourists each year. Our study was conducted in an area of approximately 49 hectares, limited by Norzagaray Street to the north and east, Paseo de la Princesa and the docks to the south, and Paseo del Morro to the west. The area comprises 868 parcels that are used as commercial centers (62%), high-population residential zones (31%), and public areas (7%). Due to access limitation and time constraints, we excluded important sites that we knew had large colonies of stray cats, which sites included La Perla, La Puntilla, and most of the rocky shore of Paseo del Morro.

Population size, density, and spatial distribution

We conducted a single 2-day visual encounter survey (VES), which consisted of counting the number of individuals present in each survey area over a specific time period (30). This technique is widely used in ecological research to estimate the diversity and abundance in a specific location or for a given species (31). In this study, 2 observers covered the north/south streets and 2 others covered the east/west streets; both pairs of observers were in action from 8:00 AM to 1:00 PM on the pertinent 2 days (both in May of 2013). To estimate the population size (N), we used the Petersen method (32), which uses a single episode of marking (or documenting) animals, followed by a second-day survey for recapturing or "re-sighting" individuals.

The population size (N) was estimated as follows:

$$N = \frac{(M+1)(C+1)}{(R+1)} - 1$$

where N = Estimate of total population size
M = Total number of animals "captured and marked" on the first day of the survey
C = Total number of animals "captured and marked" on the second day of the survey
R = Number of animals "recaptured" on the second day of the survey

We calculated normal approximation confidence intervals for the Petersen method results as follows:

$$\frac{R}{C} \pm \left\{ \alpha \left[\frac{\sqrt{(1-f)\left(\frac{R}{C}\right)\left(1-\frac{R}{C}\right)}}{(C-1)} + \frac{1}{2C} \right] \right\}$$

where:

f = fraction of total population sampled in the second sample = $\frac{R}{M}$

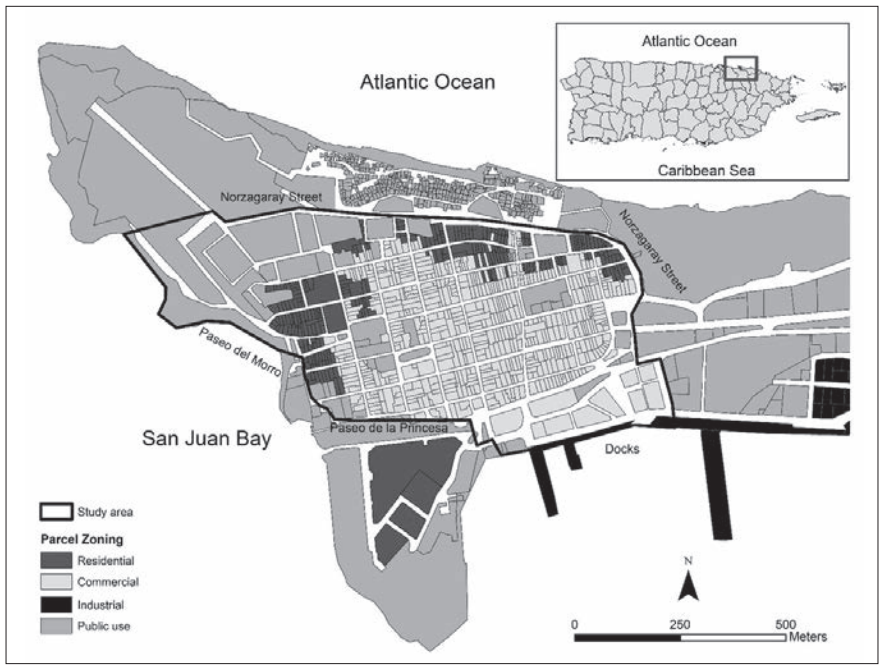

Figure 1. Map of Old San Juan depicting our study site (thick, black line) and the city zoning districts.

1/2C = correction for continuity

$\mathcal{Z}\alpha$ = standard normal deviate for (1-α) level of confidence, 1.96 (for 95% confidence limits)

Once a cat was encountered, we collected the following information about that individual: fur color and pattern, eye color, probable gender, life stage (i.e., kitten, young, mature), scars, physical condition, presence (or not) of a collar, behavior (e.g., sleeping, walking), alone or in a group, and whether the cat was neutered or not (indicated by a cut in the tip of 1 ear). In addition, we photographed the individual, registered the geographic coordinates of the site of encounter using a GPS, and provided a brief description of the site, including the presence (or lack) of feeding stations (food dishes). The information for each individual was entered using a unique identification code. Since in this study the cats were not manipulated, we did not need permission from the Institutional Animal Care and Use Committee (IACUC) to conduct the surveys. Finally, we calculated the Euclidean distance between cats location points and the feeding stations using the average nearest neighbor tool in ArcGIS 9.3.

Results

We estimated a population of 178 (±21) cats, with a density of 3.6 cats/ha. Overall, we observed 209 cats, from which 149 (71%) were identified as "new" individuals, and 60 (29%) were "recaptured," as they were identified on the first day and re-sighted on the second day of the survey. We found that 105 (70%) of the individuals were neutered, and 32 (21%) presented visible health issues, including scabies, scars, hairless areas, black spots in the mouth and/or around the eyes and ears, and blindness, while some cats were extremely underweight, despite the fact that large amounts of food were provided (Fig. 2).

We found that stray cats had a significant non-random and clustered spatial distribution (z-score = -19.39 SD; ratio = 0.29; 0.01 significance level; $p<0.0001$), with an observable greater abundance in residential and public-zoned parcels where feeding stations were available (Fig. 3).

Figure 2. Examples of stray cats in Old San Juan with poor physical conditions.

Discussion

Our study provides the first assessment of the population size and spatial distribution of stray cats in an urban neighborhood in Puerto Rico. Furthermore, we provide a description of 149 cats and their spatial locations, which data might facilitate the management and monitoring of the cats.

Although cat numbers in Old San Juan were lower than those of other urban areas where similar studies have been conducted (20, 33, 3), the density of cats in this neighborhood was higher than the densities observed in these other places. Furthermore, we found that stray cats exhibited high site fidelity to places were their caretakers lived or provided food, which at the same time facilitated the identification of individuals and the estimation of population size. VES, then, is a simple methodology for the identification of stray cats and can be used to estimate the population and assess the effectiveness of TNR programs in a given urban area.

Though our was the first study to systematically quantify the actual size of the population of stray cats in Old San Juan, we faced several limitations that should be overcome if researchers are to generate a more accurate estimation. For example, we underestimated the actual population size, as we were unable to conduct cat surveys in 2 areas within Old San Juan where we knew stray cats were abundant (i.e., Paseo del Morro and the neighborhood of La Perla) or during the time of the day when cats are most active (e.g., when they are fed, at sunset).

Our results suggest that the TNR program developed to control the population of stray cats in Old San Juan has been satisfactory, as 70% of the cats we found were neutered. However, there is a lack of past references to assess the effectiveness of the program in reducing the net population size and in reducing, as well, the nuisances associated with the presence of a large population of stray cats. The presence of pregnant females, kittens, and more than 40 unneutered adults observed during our surveys suggest that the population of stray cats will continue growing.

Though providing disease diagnostics was beyond the scope of our study, we documented the existence of several cats with poor external physical conditions and of large amounts of feces in public areas, including in a children's playground that had a sandbox and which was located next to the cat shelter. Unhealthy living conditions as a consequence of an overpopulation of stray animals could represent a neglected source of parasites and diseases for humans and indoor pets in this neighborhood. Thus, diagnostics to identify contagious diseases and parasites (such as Toxoplasma gondii) that could be

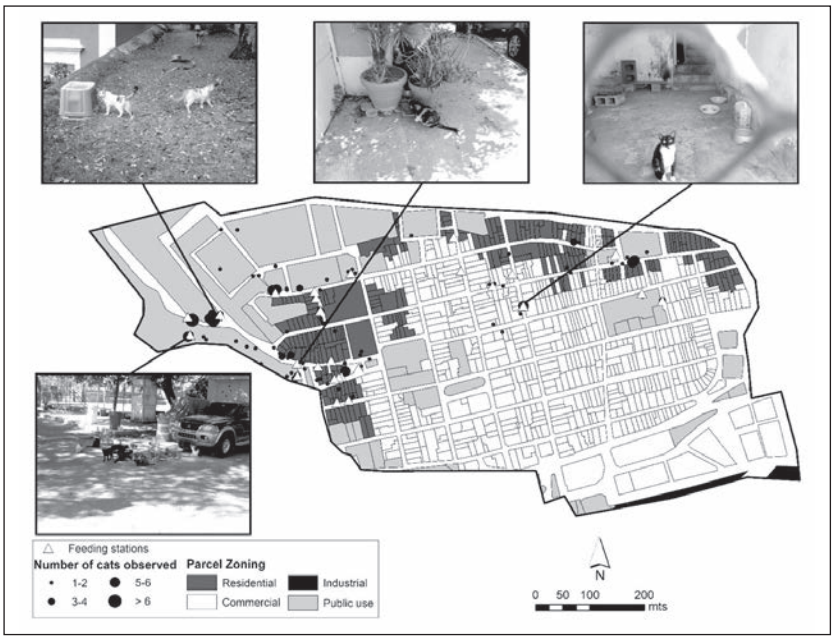

Figure 3. Number of cats (circles) and their distribution in Old San Juan overlapped to parcel zoning and feeding stations (triangles). Examples of the living conditions of the stray cats and feeding stations are shown.

transmitted from stray cats to humans are needed to better understand the implications in terms of public health (34). The management of stray cats in a highly human-populated area such as Old San Juan should involve cat caretakers and advocates, veterinarians, and governmental agencies.

Resumen

La sobrepoblación de gatos callejeros en áreas urbanas representa un riesgo potencial para los seres humanos, ya que los primeros pueden portar enfermedades como toxoplasmosis y virus como la rabia, la inmunodeficiencia felina y la leucemia felina. En el Viejo San Juan, un barrio histórico y uno de los lugares más turístico de Puerto Rico, hay una sobrepoblación de gatos callejeros. En este estudio, hemos generado información de base fundamental para desarrollar un programa de control exitoso mediante la estimación del tamaño poblacional, densidad y distribución espacial de gatos callejeros. Además, cuantificamos el número de gatos castrados, y desarrollamos una base de datos espacial con información sobre la condición física externa de cada individuo. Se estimó una población de 178 ± 21 gatos, con una densidad de 3.6 gatos / ha. En general, observamos 209 gatos de los cuales 149 (71%) fueron identificados como nuevos, y 60 (29%) fueron recapturados. Encontramos que los gatos callejeros tenían una distribución espacial significativa no aleatoria y agrupada (puntuación Z = -19.39 SD, Ratio = 0.29, p <0.0001), con una mayor abundancia en las zonas residenciales donde se les proporcionaba alimento. Un total de 105 gatos (70%) estaban castrados, y 32 (21%) individuos mostraron condiciones físicas muy pobres, incluyendo: problemas de piel, cicatrices, bajo peso y ceguera. Concluimos que los datos ecológicos y descriptivos generados en este estudio son esenciales para el control efectivo de los gatos callejeros y los impactos potenciales en los seres humanos que habitan en este vecindario.

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